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Spectrum and term system of doubly ionized silicon, Si III

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With 3 plates and 11 figures in the text

SUMMARY

The spectrum of doubly ionized silicon, Si III, has been investigated in the region from 10000 Å to 400 Å. About 360 lines have been measured and identified and 107 new energy levels established. A number of intersystem combination lines, of which $3s^2\,{}^1S_0$–$3s3p\,{}^3P_1$ falls at λ_{vac} 1892.030 Å, fix the singlet and triplet systems in relation to each other. The ${}^1G$ level of $3sng$ falls within the narrow range (~ 1 cm^{-1}) of the ${}^3G$ levels, and the four levels of $3snh$, $3sni$, etc. are coincident within the limits of the observations. A consistent system of term values has been derived, and accurate wavelengths in the vacuum region have been calculated from the term system. The ionization energy has been determined from the series $3s6h$, $7h$, and $8h$, and found to be $270\,139.3 \pm 0.4$ cm^{-1}.

Introduction

The spectra of silicon have been the subject of many investigations (see Toresson, 1960). Data for doubly ionized silicon were given by Fowler (1925) and then extended by Bowen (1932) on the basis of ultraviolet observations. These data were, however, rather incomplete. No observations were made above λ 5740 Å, and a proposed intercombination line at λ 1895 Å was erroneously classified, as will be shown below. Also, from a comparison with the isoelectronic spectra Mg I and Al II, it appeared that the identification of at least one of the deep ${}^1D_2$ terms ($3s3d$ or $3p^2$) had to be revised. Van Vleck and Whitelaw (1933) had in analogy with Al II, using a theoretical series formula, calculated the absolute value of $3s5g\,{}^3G$ and had found that the limit should be about 90 cm^{-1} higher than that derived by Bowen.

The present investigation was begun in order to clarify these points and to extend the term system as far as possible.

Experimental arrangements

Light sources. The sliding vacuum spark described earlier (Toresson, 1960) has been used for the whole spectrum. For the vacuum ultraviolet an electrodeless high-frequency discharge (see Minnhagen and Stigmark, 1954, 1957) in silicon tetrafluoride and silicon tetrachloride was also used. A fused quartz discharge tube surrounded by a coil of 5 mm copper wire was employed. By means of a large ground socket the tube was attached to the cone-shaped slit tube of the vacuum spectrograph (cf. Minnhagen, 1958). The silicon tetrafluoride gas was continuously admitted into the discharge tube by means of a needle valve. The chloride is a liquid with a rather high vapour-pressure at room temperature, About 10 cm^3 of this liquid was put into a glass tube equipped with a stopcock at one end and closed at the other; this tube, submerged in liquid air, was connected to the light source, and the system was evacuated. The gas pressure could then be regulated by lowering the level of the liquid air. The gas was in both cases mixed with argon from a gas-circulating system in order to give a reference spectrum.

The sliding vacuum-spark assembly was attached to the slit tube by means of a suitable cone of brass. Three diaphragms placed between the spark and the slit served to protect the slit from being coated by silicon.

Spectrographs. The spectrum above 2000 Å was photographed with a stigmatic concave-grating spectrograph having a plate factor of about 5 Å/mm in the first order. Below 2000 Å a grazing-incidence vacuum spectrograph with a 1.5 m N.P.L. grating was used. The plate factor varies from 5.8 Å/mm at 2200 Å to 3.1 Å/mm at 450 Å. A slit width of 4–6 μ was used. The spectrograph and the light source were evacuated to less than 10^{-3} mm Hg by means of two oil-diffusion pumps, one on each side of the slit.

Spectrograms

The spectrograms covering the region above 2000 Å have been described in the paper on Si IV (1960). The vacuum region was photographed with Ilford Q_2 and Q_1 and Kodak SWR emulsions, which were coated on thin glass because of the small radius of the Rowland circle. When the high-frequency discharge was used, the pulse power was varied and spectrograms corresponding to three different discharge conditions were taken in order to separate lines belonging to different ionization

Table 1. Reference spectra.

Spectrum	Source	Wavelength reference
C I	Electrode holders	Herzberg, 1958; Edlén, 1958
C II	Electrode holders	Glad, 1953; Herzberg, 1958; Edlén, 1958
N I	Air	Eriksson, 1958
N II	Air	Eriksson, 1958
O I	Quartz disk	Herzberg, 1958; Edlén, 1943, 1958
O II	Quartz disk	Edlén, 1934
Mg II	Electrode	Risberg, 1955
Si II	Electrodes	Shenstone, unpublished data, 1958
Si III	Electrodes	This work
Si IV	Electrodes	Toresson, 1960
Ar II	Gas	Minnhagen, 1958
Ca II	Electrode	Edlén and Risberg, 1956
Cu II	Electrode	Shenstone, 1955.

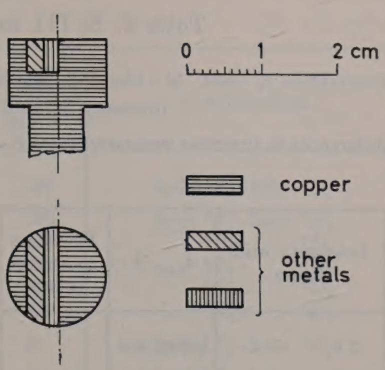

Fig. 1. A type of electrode used to furnish the spectrograms with suitable reference lines.

stages (cf. Minnhagen and Stigmark, 1957). The strongest Si II lines and the transitions between the lowest levels in Si III appeared with varying intensities on all three spectrograms. On the spectrograms taken with the highest pulse power the reasonance lines of Si IV appeared weakly. It was clear that the energy was not sufficient to give strong Si III and Si IV spectra. Spectrograms were therefore taken by means of the sliding spark with an outer spark gap of 2, 4, and 6 mm and 29, 20, and 15 turns of the induction coil, respectively (cf. Toresson, 1960). It was then possible to separate the different ionization stages of silicon.

The spectra used for wavelength references are listed in Table 1. Mg II and Ca II came from special electrodes (see Fig. 1), made of copper in which pieces of magnesium and calcium metal had been inserted. Only one silicon electrode was used when spectrograms were taken with this "reference" electrode. An upper electrode holder of carbon was used in some cases in order to give C I and C II with sufficient intensity. Si III wavelengths, calculated from terms derived entirely from the new measurements above 2000 Å, gave additional references especially about 1400 Å. The reference spectra were usually taken in the same diffraction order as the Si III spectrum.

The spectrum in the region 10000–2000 Å

Table 2 gives all the measured lines (about 250) in the wavelength interval between 10000 and 2000 Å. The table also gives calculated wavelengths (marked *c*) for some lines that were masked by strong lines.

The intensities have been estimated on a logarithmic scale. They refer to spectrograms exposed for the same length of time under the same spark conditions, and on the type of plate that is the most sensitive in each region.

The wavelengths are weighted means of measurements on two to six spectrograms, except for a few weak lines measured on only one spectrogram. The estimated uncertainty is less than about 0.02 Å for undisturbed lines, the wavelengths of which are given with three decimals. The third column shows, for comparison, the wavelengths given by Fowler (1925) and Jackson (1934). The wave-numbers in the fourth column were derived from the wavelengths in column 2 by using Edlén's (1953) table of vacuum corrections. However, for the four strong lines measured interferometrically by Jackson the wave-numbers (marked J) correspond to his wavelengths. The values given for these four lines by different authors are shown in Table 3.

Table 2. Si III lines in the region 10 000–2000 Å.

Description of lines: *bl* = blended by; *h* = hazy; *H* = very hazy; *m* = masked by. A brace in the intensity column marks that separation is difficult.

References to previous measurements: F = Fowler (1925), J = Jackson (1934). Wavelengths marked *c* are calculated.

Intensity and shape	λ_{air}, Å	Previous measurements	Wave-number, cm^{-1}		Combination
			obs.	calc.*	
2 *h*	9 799.906		10 201.38	.38	$3s4d\ ^1D_2\ -3s5p\ ^1P_1$
3 *h*	9 323.899		10 722.19	.19	$3s3d\ ^1D_2\ -3s4p\ ^1P_1$
2 *h*	9 173.267		10 898.25	*D*	$3s6f\ ^1F_3\ -3s8d\ ^1D_2$
3 *h*	8 728.019		11 454.21	.21	$3p4d\ ^1D_2\ -3p4f\ \ F\,(3\tfrac{1}{2})_3$ (?)
1 *h*	8 436.487		11 850.02	.02	$3p3d\ ^1P_1\ -3s6d\ ^1D_2$
2 *h*	8 341.931		11 984.34	.30	$3p4s\ ^1P_1\ -3p4p\ ^1D_2$
3 *h*	8 292.615		12 055.61	*I*	$3s6h\ H\ -3s8i\ I$
6 *h*	8 271.944		12 085.73	.73	$3s5p\ ^3P_0\ -3s5d\ ^3D_1$
5 *h*	8 271.377		12 086.56	.54	$^3P_1\ -\ ^3D_1$
8 *h*	8 269.324		12 089.56	.56	$^3P_1\ -\ ^3D_2$
0 *h*	8 267.75		12 091.9	.92	$^3P_2\ -\ ^3D_1$
5 *h*	8 265.640		12 094.95	.94	$^3P_2\ -\ ^3D_2$
9 *h*	8 262.568		12 099.45	.45	$^3P_2\ -\ ^3D_3$
1 *H*	8 255.81		12 109.4	.35	$3s5g\ ^3G_5\ -3s6f\ ^3F_4$
				.61	$^3G_4\ -\ ^3F_3$
				.66	$^3G_3\ -\ ^3F_2$
2 *H*	8 212.05		12 173.9	.7	$3s6f\ ^3F_{3,2}-3s8g\ ^3G_{4,3}$
				4.05	$^3F_4\ -\ ^3G_5$
3 *H* (*bl* Na I)	8 194.71		12 199.6	*H*	$3s6g\ ^3G_5\ -3s8h\ H$
3 *H*	8 194.18		12 200.4	.1	$^1G_4\ -\ H$
				.5	$^3G_4\ -\ H$
				.7	$^3G_3\ -\ H$
8 *h*	8 191.679		12 204.15	.15	$3s5f\ ^3F_4\ -3s6g\ ^3G_5$
6 *h*	8 191.16		12 204.9	5.24	$^3F_3\ -\ ^3G_4$
7 *h*	8 190.431		12 206.01	5.65	$^3F_3\ -\ ^1G_4$
				6.0	$^3F_2\ -\ ^3G_3$
11 *h*	8 103.448		12 337.03	.03	$3s5g\ ^3G_5\ -3s6h\ H$
				.37	$^1G_4\ -\ H$
9 *h*	8 102.862		12 337.93	.72	$^3G_4\ -\ H$
				8.16	$^3G_3\ -\ H$
0 *h*	7 984.20		12 521.3	.46	$3p3d\ ^1F_3\ -3p4p\ ^1D_2$
12 *h*	7 612.356		13 132.92	.92	$3s5p\ ^1P_1\ -3s5d\ ^1D_2$
1 *h*	7 532.055		13 272.93	.93	$3p3d\ ^3P_0\ -3s6s\ ^3S_1$
3 *h*	7 497.286		13 334.49	.50	$^3P_1\ -\ ^3S_1$
9 *h*	7 466.322		13 389.79	.79	$3s4d\ ^3D_3\ -3s5p\ ^3P_2$
4 *h*	7 465.669		13 390.96	.99	$^3D_2\ -\ ^3P_2$
8 *h*	7 462.624		13 396.42	.37	$^3D_2\ -\ ^3P_1$
				.92	$^3D_1\ -\ ^3P_1$
5 *h*	7 461.890		13 397.74	.73	$^3D_1\ -\ ^3P_0$

(Table 2, cont.)

Intensity and shape	λ_{air}, Å	Previous measurements	Wave-number, cm^{-1}		Combination
			obs.	calc.*	
4 *h*	7 442.327		13 432.96	.95	$3p3d\ ^3P_2-3s6s\ ^3S_1$
1 *h*	7 425.10		13 464.1	.00	$3p4s\ ^3P_2-3s6d\ ^3D_2$
3 *h*	7 408.467		13 494.35	.35	$^3P_2-\quad ^3D_3$
0 *h*	7 278.79		13 734.8	.86	$^3P_1-\quad ^3D_1$
2 *h*	7 267.090		13 756.87	.86	$^3P_1-\quad ^3D_2$
1 *h*	7 211.836		13 862.28	.28	$^3P_0-\quad ^3D_1$
1 *h*	7 189.072		13 906.17	*S*	$3p4s\ ^1P_1-3s8s\ ^1S_0$
2 *H*	7 151.08		13 980.0	*D*	$3s6f\ ^1F_3-3s9d\ ^1D_2$
5 *h bl* Si IV	7 047.58		14 185.4	.55	$3p3d\ ^1P_1-3p4p\ ^1P_1$
7 *h*	6 851.65		14 591.0	0.76	$3s4d\ ^3D_3-3p3d\ ^3P_2$
3 *h*	6 851.18		14 592.0	1.96	$^3D_2-\quad ^3P_2$
2 *h*	6 834.38		14 627.9	.73	$3s5p\ ^3P_0-3s6s\ ^3S_1$
4 *h*	6 834.08		14 628.5	.54	$^3P_1-\quad ^3S_1$
6 *h*	6 831.560		14 633.91	.92	$^3P_2-\quad ^3S_1$
½ *h*	6 812.200		14 675.50	*P*	$3s6p\ ^3P_1-3s7d\ ^3D_2$
0 *h*	6 810.79		14 678.5	.4	$^3P_0-\quad ^3D_1$
1 *h*	6 810.594		14 678.96	*P*	$^3P_2-\quad ^3D_3$
4 *h*	6 805.244		14 690.50	.41 .96	$3s4d\ ^3D_2-3p3d\ ^3P_1$ $^3D_1-\quad ^3P_1$
2 *h*	6 776.623		14 752.54	.53	$^3D_1-\quad ^3P_0$
0 *H*	6 662.95		15 004.2	*D*	$3s6f\ ^3F-3s9d\ ^3D$
2 *h*	6 535.163		15 297.61	*I*	$3s6h\ \ H-3s9i\ \ I$
6 *h*	6 524.357		15 322.95	.55 .98	$3s5d\ ^3D_3-3s6f\ ^3F_3$ $^3D_3-\quad ^3F_4$
4 *h*	6 522.626		15 327.01	6.67 .06	$^3D_2-\quad ^3F_2$ $^3D_2-\quad ^3F_3$
3 *h*	6 521.485		15.329.69	.69	$^3D_1-\quad ^3F_2$
1 *H*	6 473.96		15 442.2	*G*	$3s6f\ ^3F-3s9g\ \ G$
2 *H*	6 471.86		15 447.2	.2	$3s6g\ ^3G_5-3s9h\ \ H$
7	6 314.459		15 832.29	.29	$3s5p\ ^1P_1-3s6s\ ^1S_0$
3	6 173.712		16 193.23	.49	$3s4s\ ^1S_0-3s4p\ ^3P_1$
3 *h*	6 169.835		16 203.41	.41	$3s5d\ ^1D_2-3s6f\ ^1F_3$
2	6 152.556		16 248.91	*D*	$3s6p\ ^1P_1-3s7d\ ^1D_2$
1	6 111.571		16 357.88	.88	$3p4s\ ^3P_1-3p4p\ ^1P_1$
10 *h*	5 898.788		16 947.94	.94	$3s5f\ ^1F_3-3s6g\ ^1G_4$
3 *h*	5 810.187		17 206.38	*P*	$3s5d\ ^1D_2-3s7p\ ^1P_1$
20	5 739.733	F .762	17 417.58	.58	$3s4s\ ^1S_0-3s4p\ ^1P_1$
1 *h*	5 724.609		17 463.60	*F*	$3s6d\ ^1D_2-3s9f\ ^1F_3$
8	5 716.289		17 489.01	.02	$3s4f\ ^3F_4-3s5d\ ^3D_3$
7	5 704.598		17 524.86	.88	$^3F_3-\quad ^3D_2$
4	5 703.121		17.529.40	.39	$^3F_3-\quad ^3D_3$
7 *bl* Al III	5 696.50		17 549.8	.79	$^3F_2-\quad ^3D_1$
3	5 695.522		17 552.78	.81	$^3F_2-\quad ^3D_2$

(Table 2, cont.)

Intensity and shape	λ_{air}, Å	Previous measurements	Wave-number, cm^{-1} obs.	Wave-number, cm^{-1} calc.*	Combination
2	5 601.461		17 847.53	*P*	$3s5d\ ^3D_1-3s7p\ ^3P_0$
3	5 600.952		17 849.15	.15	$^3D_2-\ {}^3P_1$
0	5 600.00		17 852.2	.17	$^3D_1-\ {}^3P_1$
4	5 599.246		17 854.59	*P*	$^3D_3-\ {}^3P_2$
½	5 597.90		17 858.9	9.10	$^3D_2-\ {}^3P_2$
0	5 579.94		17 916.4	.65	$3p4s\ ^3P_2-3p4p\ ^3D_1$
3	5 539.926		18 045.77	.77	$^3P_2-\ {}^3D_2$
3	5 490.114		18 209.50	.51	$^3P_1-\ {}^3D_1$
7	5 473.045	F .09	18 266.29	.30	$^3P_2-\ {}^3D_3$
4	5 451.961		18 336.93	.93	$^3P_0-\ {}^3D_1$
6	5 451.462		18 338.61	.63	$^3P_1-\ {}^3D_2$
1	5 310.390		18 825.77	*D*	$3s5f\ ^3F_2-3s7d\ ^3D_1$
1	5 307.709		18 835.28	*F*	$^3F_3-\ {}^3D_2$
2	5 303.415		18 850.53	.48	$^3F_4-\ {}^3D_3$
5	5 197.264		19 235.54	.64	$3p3d\ ^1P_1-3p4p\ ^1D_2$
3	5 135.110		19 468.35	.29	$^1P_1-\ {}^3P_2$
8 *h*	5 114.116		19 548.27	*G*	$3s5f\ ^3F_4-3s7g\ ^3G_5$
7 *h*	5 113.76		19 549.6	.23 .6	$^3F_3-\ {}^3G_4$ $^3F_2-\ {}^3G_3$
10 *h*	5 091.419		19 635.42	4.94 .28 .63 6.07	$3s5g\ ^3G_5-3s7h\ H$ $^1G_4-\ H$ $^3G_4-\ H$ $^3G_3-\ H$
m O II	4 943.260c		20 223.	.92	$3s5s\ ^3S_1-3p4s\ ^3P_0$
4	4 912.332		20 351.25	.34	$^3S_1-\ {}^3P_1$
5 *bl* O II	4 842.57		20 644.4	.20	$^3S_1-\ {}^3P_2$
18	4 828.968	F .923	20 702.58	1.96 .65	$3s4f\ ^3F_4-3s5g\ ^3G_4$ $^3F_4-\ {}^3G_5$
16	4 819.718	F .740	20 742.30	1.89 .33	$^3F_3-\ {}^3G_3$ $^3F_3-\ {}^3G_4$
15	4 813.330	F .290	20 769.83	.82	$^3F_2-\ {}^3G_3$
8	4 800.428		20 825.65	.66	$3s5s\ ^1S_0-3p3d\ ^1P_1$
2	4 734.627		21 115.08	.11	$3p4s\ ^3P_2-3p4p\ ^1D_2$
7	4 730.519		21 133.42	.41	$^3P_2-\ {}^3P_1$
16	4 716.651	J .654	J 21 195.54	.54	$3s4d\ ^1D_2-3s5f\ ^1F_3$
7	4 683.797	F .774	21 344.23	.24	$3p4s\ ^3P_1-3p4p\ ^3P_0$
9	4 683.022	F .018	21 347.76	.76	$^3P_2-\ {}^3P_2$
1	4 669.89		21 407.8	.97	$^3P_1-\ {}^1D_2$
8	4 665.869	F .87	21 426.24	.27	$^3P_1-\ {}^3P_1$
7	4 638.277		21 553.69	.69	$^3P_0-\ {}^3P_1$
7	4 619.657		21 640.57	.62	$^3P_1-\ {}^3P_2$
20	4 574.759	J .758	J 21 852.96	.96	$3s4s\ ^3S_1-3s4p\ ^3P_0$
25	4 567.823	J .841	J 21 886.05	.05	$^3S_1-\ {}^3P_1$
8	4 553.996		21 952.59	.58	$3p4s\ ^3P_2-3p4p\ ^3S_1$
30	4 552.616	J .622	J 21 959.21	.21	$3s4s\ ^3S_1-3s4p\ ^3P_2$
6	4 494.048		22 245.41	.44	$3p4s\ ^3P_1-3p4p\ ^3S_1$

(Table 2, cont.)

Intensity and shape	λ_{air}, Å	Previous measurements	Wave-number, cm^{-1}		Combination
			obs.	calc.*	
0 *h*	4 486.28		22 283.9	.62	$3p4s\ ^3P_2-3s7d\ ^3D_2$
3 *h*	4 482.884		22 300.81	.86	$^3P_2-\quad ^3D_3$
2	4 468.452		22 372.84	.86	$3p4s\ ^3P_0-3p4p\ ^3S_1$
0	4 461.27		22 408.9	9.06	$3s5f\ ^1F_3-3p4p\ ^1D_2$
1 *h*	4 428.146		22 576.48	*D*	$3p4s\ ^3P_1-3s7d\ ^3D_2$
4 *h*	4 423.556		22 599.90	*F*	$3p4p\ ^3D_3-3p4d\ ^3F_4$ (?)
8 *h*	4 406.721		22 686.24	5.98 .26	$3s5d\ ^3D_3-3s7f\ ^3F_3$ $^3D_3-\quad ^3F_4$
6 *h*	4 405.901		22 690.46	.27 .49	$^3D_2-\quad ^3F_2$ $^3D_2-\quad ^3F_3$
4 *h*	4 405.351		22 693.29	.29	$^3D_1-\quad ^3F_2$
m Si IV	4 403.830 *c*		22 701.	.13	$3s5d\ ^1D_2-3s7f\ ^1F_3$
1 *h*	4 379.876		22 825.28	.14	$3p3d\ ^3D_3-3s6d\ ^3D_3$
8 *h*	4 377.626		22 837.01	.03	$3s4f\ ^1F_3-3s5d\ ^1D_2$
4 *h*	4 356.821		22 946.06		$3p4f\ F(3\frac{1}{2})_4-3p5g\ G(4\frac{1}{2})_5$ (?)
2 *h*	4 356.100		22 949.86	*G*	$F(3\frac{1}{2})_3-\quad G(3\frac{1}{2})_3$ (?)
3 *h*	4 355.525		22 952.89		$F(3\frac{1}{2})_4-\quad G(4\frac{1}{2})_4$ (?)
3 *h*	4 355.281		22 954.18	*G*	$F(3\frac{1}{2})_3-\quad G(3\frac{1}{2})_4$ (?)
2 *h*	4 352.810		22 967.21	.26	$F(2\frac{1}{2})_3-\quad G(3\frac{1}{2})_3$ (?)
2 *h*	4 351.974		22 971.62	.58	$F(2\frac{1}{2})_3-\quad G(3\frac{1}{2})_4$ (?)
8	4 341.400		23 027.57	*S*	$3p4s\ ^1P_1-3p4p\ ^1S_0$
9	4 338.501	F .52	23 042.96	.96	$3p^2\ ^1S_0-3s4p\ ^1P_1$
2 *h*	4 211.679		23 736.82	*D*	$3s5f\ ^3F_4-3s8d\ ^3D_3$
5 *h*	4 115.504		24 291.51	.61	$3s5f\ ^1F_3-3s7g\ ^1G_4$
3 *h*	4 111.512		24 315.09	*G*	$3s5f\ ^3F_4-3s8g\ ^3G_5$
2 *h*	4 111.255		24 316.61	*G*	$^3F_{3,2}-\quad ^3G_{4,3}$
8	4 102.422		24 368.97	.96	$3s4d\ ^1D_2-3p3d\ ^1P_1$
5 *H*	4 101.86		24 372.3	.0 .4 .7 3.2	$3s5g\ ^3G_5-3s8h\ H$ $^1G_4-\quad H$ $^3G_4-\quad H$ $^3G_3-\quad H$
2 *h*	4 064.113		24 598.67	.57	$3p4p\ ^1P_1-3p4d\ ^1D_2$ (?)
2	4 030.752		24 802.26	.27	$3s4d\ ^3D_1-3p4s\ ^3P_0$
4	4 010.192		24 929.41	.14 .69	$^3D_2-\quad ^3P_1$ $^3D_1-\quad ^3P_1$
5	3 981.238		25 110.71	.22 .54 1.09	$3s5f\ ^1F_3-3s7d\ ^1D_2$ $3s4p\ ^1P_1-3s4d\ ^3D_1$ $^1P_1-\quad ^3D_2$
6	3 963.838		25 220.94	.80 2.00	$3s4d\ ^3D_3-3p4s\ ^3P_2$ $^3D_2-\quad ^3P_2$
2 *h*	3 956.66		25 266.7	.82	$3s5p\ ^3P_0-3s6d\ ^3D_1$
1 *h*	3 956.55		25 267.4	.63	$^3P_1-\quad ^3D_1$
4 *h*	3 953.080		25 289.57	.63	$^3P_1-\quad ^3D_2$

(Table 2, cont.)

Intensity and shape	λ_{air}, Å	Previous measurements	Wave-number, cm^{-1}		Combination
			obs.	calc.*	
1 *h*	3 952.239		25 294.95	5.01	$3s5p\ {}^3P_2-3s6d\ {}^3D_2$
6 *h*	3 947.488		25 325.40	.36	${}^3P_2-\quad {}^3D_3$
20	3 924.468	F .44	25 473.95	*G*	$3s4f\ {}^1F_3-3s5g\ {}^1G_4$
7	3 842.458		26 017.63	.60	$3s5p\ {}^1P_1-3s6d\ {}^1D_2$
30	3 806.544	F .56	26 263.09	{ 2.02	$3s4p\ {}^3P_2-3s4d\ {}^3D_2$
				.22	${}^3P_2-\quad {}^3D_3$
25	3 796.114	F .11	26 335.25	{ 4.63	${}^3P_1-\quad {}^3D_1$
				.18	${}^3P_1-\quad {}^3D_2$
20 *bl* O III	3 791.41	F .41	26 367.9	.72	${}^3P_0-\quad {}^3D_1$
{ 2 *h*	3 682.25		27 149.6	.64	$3s5p\ {}^3P_0-3s7s\ {}^3S_1$
{ 5 *h*	3 682.15		27 150.3	.45	${}^3P_1-\quad {}^3S_1$
7 *h*	3 681.402		27 155.83	*S*	${}^3P_2-\quad {}^3S_1$
3 *h*	3 676.731		27 190.33	.33	$3s5d\ {}^1D_2-3s8f\ {}^1F_3$
2 *h*	3 662.366		27 296.98	7.01	$3p3d\ {}^3D_2-3p4p\ {}^3D_1$
4 *h*	3 655.112		27 351.15	.16	${}^3D_1-\quad {}^3D_1$
2 *h*	3 651.721		27 376.55	.56	${}^3D_3-\quad {}^3D_2$
6 *h*	3 645.123		27 426.10	.13	${}^3D_2-\quad {}^3D_2$
5 *h*	3 639.445		27 468.89	{ .54	$3s5d\ {}^3D_3-3s8f\ {}^3F_3$
				.92	${}^3D_3-\quad {}^3F_4$
3 *h*	3 638.898		27 473.02	{ 2.82	${}^3D_2-\quad {}^3F_2$
				.05	${}^3D_2-\quad {}^3F_3$
2 *h*	3 638.524		27 475.84	.84	${}^3D_1-\quad {}^3F_2$
2 *h*	3 637.943		27 480.23	.28	$3p3d\ {}^3D_1-3p4p\ {}^3D_2$
8 *h*	3 622.538		27 597.09	.09	${}^3D_3-\quad {}^3D_3$
3 *h*	3 619.581		27 619.63	.6	$3s5g\ {}^3G_5-3s9h\ \ H$
1 *h*	3 616.040		27 646.68	.66	$3p3d\ {}^3D_2-3p4p\ {}^3D_3$
20	3 590.465	F .46	27 843.60	.60	$3s4p\ {}^1P_1-3s4d\ {}^1D_2$
3 *h*	3 580.050		27 924.60	.62	$3p3d\ {}^3F_4-3s5d\ {}^3D_3$
8	3 569.673		28 005.78	*S*	$3s5p\ {}^1P_1-3s7s\ {}^1S_0$
2 *h bl* band	3 563.11		28 057.4	.72	$3p3d\ {}^3F_3-3s5d\ {}^3D_2$
1 *h bl* band	3 550.38		28 158.0	.04	${}^3F_2-\quad {}^3D_1$
9	3 525.939	F .90	28 353.13	.13	$3s5p\ {}^1P_1-3p4p\ {}^1P_1$
15	3 486.911	F .93	28 670.47	{ 69.14	$3s4d\ {}^3D_3-3s5f\ {}^3F_3$
				69.4	${}^3D_2-\quad {}^3F_2$
				.0	${}^3D_1-\quad {}^3F_2$
				.34	${}^3D_2-\quad {}^3F_3$
				1.18	${}^3D_3-\quad {}^3F_4$
m O II, O III	3 447.938 *c*		28 994.	.53	$3s4p\ {}^3P_2-3s4d\ {}^1D_2$
5 *bl* O III	3 440.37		29 058.3	*G*	$3s5f\ {}^1F_3-3s8g\ {}^1G_4$
3	3 439.242		29 067.84	.69	$3s4p\ {}^3P_1-3s4d\ {}^1D_2$
m (?)	3 361.343 *c*		29 741.	.47	$3s5p\ {}^3P_0-3p4p\ {}^3D_1$
2	3 346.717		29 871.44	.40	${}^3P_1-\quad {}^3D_2$
4	3 321.578		30 097.51	.31	${}^3P_2-\quad {}^3D_3$
1	3 283.570		30 445.89	.90	$3p3d\ {}^3D_3-3p4p\ {}^1D_2$

(Table 2, cont.)

Intensity and shape	λ_{air}, Å	Previous measurements	Wave-number, cm^{-1}		Combination
			obs.	calc.*	
7	3 279.258	F .25	30 485.92	.89	$3p3d\ ^3D_1-3p4p\ ^3P_0$
10	3 276.264	F .25	30 513.78	.77	$^3D_2-\ ^3P_1$
6	3 270.456		30 567.96	.92	$^3D_1-\ ^3P_1$
12	3 258.664	F .67	30 678.57	.55	$^3D_3-\ ^3P_2$
7	3 254.800	F .79	30 714.99	.93	$3s4f\ ^3F_4-3s6d\ ^3D_3$
5	3 253.741		30 725.00	4.95	$^3F_3-\ ^3D_2$
7	3 253.401	F .44	30 728.21	.12	$3p3d\ ^3D_2-3p4p\ ^3P_2$
4	3 253.117		30 730.89	.88	$3s4f\ ^3F_2-3s6d\ ^3D_1$
1 *h*	3 251.871		30 742.66	.7	$3s5d\ ^3D_3-3s9f\ ^3F$
½ *h*	3 251.383		30 747.27	.2	$^3D_2-\ ^3F$
0 *h*	3 251.07 *c*		30 750.	.2	$^3D_1-\ ^3F$
1	3 250.79		30 752.9	.88	$3s4f\ ^3F_2-3s6d\ ^3D_2$
1	3 250.56		30 755.1	.30	$^3F_3-\ ^3D_3$
15	3 241.622	F .67	30 839.86	.82	$3s4p\ ^3P_2-3s5s\ ^3S_1$
14	3 233.954	F 4.00	30 912.98	.98	$^3P_1-\ ^3S_1$
12	3 230.499	F .55	30 946.03	.07	$^3P_0-\ ^3S_1$
7	3 216.249	F .26	31 083.14	.14	$3s4d\ ^1D_2-3p3d\ ^1F_3$
15	3 210.554	F .52	31 138.27	7.56	$3p3d\ ^3F_4-3s5g\ ^3G_4$
				.25	$^3F_4-\ ^3G_5$
14	3 196.504	F .50	31 275.14	4.73	$^3F_3-\ ^3G_3$
				.17	$^3F_3-\ ^3G_4$
				.52	$^3F_3-\ ^1G_4$
13	3 186.022	F .01	31 378.03	.07	$^3F_2-\ ^3G_3$
16	3 185.125	F .16	31 386.87	.90	$3s4p\ ^1P_1-3s5s\ ^1S_0$
2 *bl* Si IV	3 165.38		31 582.7	.97	$3p3d\ ^3P_1-3p4p\ ^3P_0$
2	3 163.281		31 603.59	.43	$^3P_0-\ ^3P_1$
8	3 161.610	F .63	31 620.30	.30	$3s4d\ ^1D_2-3p4s\ ^1P_1$
1	3 157.159		31 664.88	5.00	$3p3d\ ^3P_1-3p4p\ ^3P_1$
7	3 147.371	F .38	31 763.35	.45	$^3P_2-\ ^3P_1$
3	3 135.906		31 879.47	.35	$^3P_1-\ ^3P_2$
6	3 126.267	F .25	31 977.76	.80	$^3P_2-\ ^3P_2$
16	3 096.826	F .786	32 281.76	.76	$3s3d\ ^3D_1-3s4p\ ^3P_0$
5	3 093.65	F .613	32 314.9	.85	$^3D_1-\ ^3P_1$
20	3 093.424	F .423	32 317.26	.26	$^3D_2-\ ^3P_1$
	3 086.666 *c*	F .620	32 388.	.01	$^3D_1-\ ^3P_2$
6	3 086.46	F .429	32 390.2	.42	$^3D_2-\ ^3P_2$
25	3 086.236	F .225	32 392.52	.52	$^3D_3-\ ^3P_2$
2	3 083.363		32 422.70	.60	$3p3d\ ^3P_0-3p4p\ ^3S_1$
4	3 077.523	F .56	32 484.23	.17	$^3P_1-\ ^3S_1$
7	3 068.238		32 582.52	.62	$^3P_2-\ ^3S_1$
3	3 046.284		32 817.34	*P*	$3s4d\ ^3D_1-3s6p\ ^3P_0$
5	3 045.076	F .10	32 830.35	.12	$^3D_2-\ ^3P_1$
				.67	$^3D_1-\ ^3P_1$
7	3 043.932	F .97	32 842.70	.70	$^3D_3-\ ^3P_2$
9	3 040.933	F .93	32 875.08	4.16	$3s4f\ ^3F_4-3s6g\ ^3G_4$
				.11	$^3F_4-\ ^3G_5$

(Table 2, cont.)

Intensity and shape	λ_{air}, Å	Previous measure-ments	Wave-number, cm^{-1}		Combination
			obs.	calc.*	
8	3 037.287	F .26	32 914.54	.33	$3s4f\ ^3F_3-3s6g\ ^3G_3$
				.53	$^3F_3-\ \ ^3G_4$
6	3 034.732	F .74	32 942.25	.26	$^3F_2-\ \ ^3G_3$
4 *bl* O II	3 032.66		32 964.7	.42	$3s5p\ ^3P_2-3p4p\ ^3P_1$
5	3 013.091		33 178.84	.77	$^3P_2-\ \ ^3P_2$
5	2 980.519		33 541.41	.35	$3s3d\ ^3D_2-3s4p\ ^1P_1$
3 *bl* Fe I	2 959.67		33 777.6	.40	$3s5p\ ^3P_0-3p4p\ ^3S_1$
				8.21	$^3P_1-\ \ ^3S_1$
5	2 959.150		33 783.61	.59	$^3P_2-\ \ ^3S_1$
2 *bl* band	2 875.09		34 771.4	0.73	$3s5p\ ^3P_0-3s8s\ ^3S_1$
				.54	$^3P_1-\ \ ^3S_1$
4	2 874.626		34 776.92	*S*	$^3P_2-\ \ ^3S_1$
5	2 839.622		35 205.60	.53	$3s4f\ ^3F_2-3p4p\ ^3D_1$
7	2 831.490	F. 51	35 306.71	.72	$^3F_3-\ \ ^3D_2$
1 *bl* band	2 830.02		35 325.0	.09	$3s5p\ ^1P_1-3s8s\ ^1S_0$
1 *bl* band	2 829.23		35 335.0	4.65	$3s4f\ ^3F_2-3p4p\ ^3D_2$
9	2 817.110	F .09	35 486.92	.88	$^3F_4-\ \ ^3D_3$
m band	2 813.912 *c*		35 527.	.25	$^3F_3-\ \ ^3D_3$
14	2 655.512		37 646.32	.21	$3s4f\ ^1F_3-3s6g\ ^1G_4$
11	2 640.788	F .80	37 856.20	.21	$3p3d\ ^1D_2-3p4p\ ^1P_1$
14	2 559.210	F .22	39 062.84	3.06	$3s3d\ ^1D_2-3s4f\ ^1F_3$
10	2 546.093	F .10	39 264.08	.09	$3s3d\ ^1D_2-3p3d\ ^1D_2$
25	2 541.818	F .83	39 330.11	.11	$3s3p\ ^1P_1-3p^2\ \ ^1D_2$
m Si I	2 528.471 *c*		39 537.	.71	$3s4d\ ^1D_2-3s6f\ ^1F_3$
m Cu II	2 485.623 *c*		40 219.	.23	$3s4f\ ^3F_4-3s7g\ ^3G_5$
6	2 483.196		40 258.52	*G*	$^3F_3-\ \ ^3G_4$
3	2 481.508		40 285.92	*G*	$^3F_2-\ \ ^3G_3$
11	2 449.484	F .53	40 812.56	1.79	$3s4d\ ^3D_3-3s6f\ ^3F_3$
				.22	$^3D_3-\ \ ^3F_4$
				.60	$^3D_2-\ \ ^3F_2$
				.99	$^3D_2-\ \ ^3F_3$
				3.15	$^3D_1-\ \ ^3F_2$
7 *bl* strong band	2 429.35		41 150.8	.53	$3p3d\ ^3F_4-3s6d\ ^3D_3$
m strong band	2 423.049 *c*		41 257.	.79	$^3F_3-\ \ ^3D_2$
m strong band	2 418.281 *c*		41 339.	.13	$^3F_2-\ \ ^3D_1$
2 *h*	2 329.931		42 906.56	.30	$3p3d\ ^1D_2-3p4p\ ^1D_2$
10	2 308.191	F .18	43 310.65	09.76	$3p3d\ ^3F_4-3s6g\ ^3G_4$
				.71	$^3F_4-\ \ ^3G_5$
m band	2 307.107 *c*		43 330.	.99	$3s4d\ ^3D_1-3s7p\ ^3P_0$
1 *h bl* band	2 306.889 *c*		43 335.	.08	$^3D_2-\ \ ^3P_1$
2 *h bl* band	2 306.42		43 343.8	.83	$^3D_3-\ \ ^3P_2$
8	2 300.930	F .90	43 447.32	.17	$3p3d\ ^3F_3-3s6g\ ^3G_3$
				.37	$^3F_3-\ \ ^3G_4$
10	2 296.873	**	43 524.04	.15	$3p3d\ ^1F_3-3p4f\ \ F(3\tfrac{1}{2})_3$ (?)

(Table 2, cont.)

Intensity and shape	λ_{air}, Å	Previous measurements	Wave-number, cm^{-1} obs.	calc.*	Combination
6	2 295.476		43 550.54	.51	$3p3d\ ^3F_2$–$3s6g\ ^3G_3$
2 *h*	2 222.01		44 990.2	89.88	$3s4f\ ^1F_3$–$3s7g\ ^1G_4$
3	2 182.049		45 814.14	3.78	$3p3d\ ^3F_2$–$3p4p\ ^3D_1$
4	2 180.836		45 839.62	.56	$^3F_3$– $^3D_2$
5	2 176.894		45 922.62	.48	$^3F_4$– $^3D_3$
1	2 171.559		46 035.43	.43	$3s4d\ ^1D_2$–$3s7f\ ^1F_3$
0	2 170.42		46 059.7	60.09	$3p3d\ ^3F_3$–$3p4p\ ^3D_3$
2	2 157.280		46 340.10	*P*	$3p4s\ ^1P_1$–$3p5p\ ^1P_1$ (?)
2 *h*	2 075.04		48 176.4	5.50	$3s4d\ ^3D_3$–$3s7f\ ^3F_4$
				.42	$^3D_2$– $^3F_3$
				.75	$^3D_1$– $^3F_2$
2	2 049.913		48 766.93	7.17	$3s3d\ ^1D_2$–$3s5p\ ^1P_1$

* A lettter in this column indicates that the level is determined from this line alone.

** This line coincides with the strong C III line at λ 2296.870, but as no other C III lines appear in the same spectrograms and the line behaves like Si III it has been retained in the list of Si III lines.

Table 3. Wavelengths (λ_{air}) from different measurements of four strong visible lines of Si III.

Barrell (1923)	Fowler (1925)	Jackson (1934)	This work (1960)
4 716.	.658	.654	.651
4 574.737	.777	.758	.759
4 567.824	.872	.841	.823
4 552.611	.654	.622	.616

Of the lines that have been experimentally classified as Si III all have been identified with combinations in the term system of Si III, except for a few very weak lines. The latter have not been included in Table 2 as it is uncertain whether they belong to Si III.

Si III lines in the vacuum region

In the region below 2000 Å a total of 108 lines were measured and classified as Si III, all of which have now been identified.

Table 4 gives under the heading λ_{obs} the weighted means of measurements on two to twelve spectrograms (cf. Table 5, column 7). The weak lines λλ 879, 690, 678, 565, and 520 Å were measured on only one spectrogram. The uncertainty in the observed wavelengths is estimated to be less than 0.01 Å. The strong narrow pair at λλ 1298.95 Å and 1298.89 Å was resolved on a spectrogram taken by Edlén with a 2-m normal-incidence vacuum spectrograph at the Massachusetts Institute of Technology in 1937.

It is very curious that two of the strongest transitions in the whole spectrum, $3s^2\,^1S_0$–$3s3p\,^1P_1$ and $3s3p\,^1P_1$–$3s3d\,^1D_2$ fall so close together at 1206 Å that it has not

Table 4. Calculated and observed Si III lines in the vacuum region (λ_{vac}).

Starred values are based entirely on observations above 2000 Å. Intensity figures are given in parentheses, following λ_{obs}.

Combination	λ_{calc}, Å	λ_{obs}, Å
$3s4d\ ^1D_2-3s8f\ ^1F_3$	1 979.233*	*bl* Si I
$3s4p\ ^1P_1-3s5d\ ^1D_2$	1 953.968*	
$3s^2\ ^1S_0-3s3p\ ^3P_1$	1 892.030	.030 (3)
$3s4p\ ^1P_1-3s6s\ ^1S_0$	1 856.070*	.062 (1)
$3p^2\ ^1D_2-3s4p\ ^1P_1$	1 842.548	.547 (9)
$3s4p\ ^3P_2-3s6s\ ^3S_1$	1 842.064*	
$^3P_1-\ ^3S_1$	1 839.585*	
$^3P_0-\ ^3S_1$	1 838.466*	
$3s4s\ ^1S_0-3s5p\ ^1P_1$	1 803.018*	.023 (3)
$3s3d\ ^3D_1-3p3d\ ^3F_2$	1 786.515*	
$^3D_2-\ ^3F_2$	1 786.438*	
$^3D_3-\ ^3F_2$	1 786.371*	
$^3D_2-\ ^3F_3$	1 783.146*	
$^3D_3-\ ^3F_3$	1 783.079*	
$^3D_3-\ ^3F_4$	1 778.715*	
$3s3d\ ^1D_2-3s5f\ ^1F_3$	1 673.323*	.315 (7)
$3p^2\ ^1S_0-3s5p\ ^1P_1$	1 636.984*	.990 (1)
$3s4s\ ^3S_1-3s5p\ ^3P_2$	1 623.055*	
$^3S_1-\ ^3P_1$	1 622.913*	
$^3S_1-\ ^3P_0$	1 622.892*	
$3s3d\ ^1D_2-3p3d\ ^1P_1$	1 588.947*	.950 (2)
$3s4p\ ^1P_1-3s6d\ ^1D_2$	1 560.974*	
$3p3d\ ^1F_3-3p5f\ F(3\frac{1}{2})_3(?)$	1 513.	.533 (2)
$3s4p\ ^1P_1-3p4p\ ^1P_1$	1 506.067*	.060 (6)
$3s3d\ ^3D_1-3s4f\ ^3F_2$	1 501.881*	.870 (9)
$^3D_2-\ ^3F_2$	1 501.827*	
$^3D_3-\ ^3F_2$	1 501.780*	
$^3D_2-\ ^3F_3$	1 501.197*	.191 (10)
$^3D_3-\ ^3F_3$	1 501.150*	
$^3D_3-\ ^3F_4$	1 500.241*	.241 (12)
$3s3d\ ^1D_2-3s6p\ ^1P_1$	1 457.245	.253 (5)
$3s3p\ ^3P_2-3p^2\ ^1D_2$	1 447.188	.196 (6)
$^3P_1-\ ^1D_2$	1 441.727	.732 (5)
$3s4p\ ^3P_2-3p4p\ ^3D_1$	1 440.908*	
$^3P_1-\ ^3D_1$	1 439.391*	.391 (2)
$^3P_0-\ ^3D_1$	1 438.706*	.702 (2)
$^3P_2-\ ^3D_2$	1 438.232*	.228 (2)
$^3P_1-\ ^3D_2$	1 436.721*	.724 (4)
$3s4s\ ^1S_0-3p3d\ ^1P_1$	1 436.160*	.166 (7)
$3s3d\ ^1D_2-3p3d\ ^1F_3$	1 435.772*	.776 (8)
$3s4p\ ^3P_2-3p4p\ ^3D_3$	1 433.685*	.690 (6)
$3s3d\ ^1D_2-3p4s\ ^1P_1$	1 424.784*	.775 (2)
$3s3p\ ^1P_1-3p^2\ ^1S_0$	1 417.237	.237 (13)
$3s4p\ ^1P_1-3p4p\ ^1D_2$	1 399.615*	
$3s3d\ ^3D_1-3s5p\ ^3P_2$	1 388.098*	7.992 (5)
$^3D_2-\ ^3P_2$	1 388.052*	
$^3D_3-\ ^3P_2$	1 388.011*	
$^3D_1-\ ^3P_1$	1 387.994*	
$^3D_1-\ ^3P_0$	1 387.979*	
$^3D_2-\ ^3P_1$	1 387.948*	
$3s4p\ ^3P_1-3p4p\ ^3P_0$	1 377.248*	.238 (2)
$^3P_2-\ ^3P_1$	1 377.080*	.082 (3)
$^3P_1-\ ^3P_1$	1 375.694*	.688 (2)
$^3P_0-\ ^3P_1$	1 375.068*	.083 (2)
$^3P_2-\ ^3P_2$	1 373.027*	.030 (5)
$^3P_1-\ ^3P_2$	1 371.649*	.652 (3)
$3s4s\ ^3S_1-3p4s\ ^3P_0$	1 369.432*	.437 (5)
$^3S_1-\ ^3P_1$	1 367.047*	.049 (7)
$3s3d\ ^3D_1-3p3d\ ^3P_2$	1 365.337*	.262 (8)
$^3D_2-\ ^3P_2$	1 365.292*	
$^3D_3-\ ^3P_2$	1 365.253*	
$^3D_1-\ ^3P_1$	1 363.504*	.472 (7)
$^3D_2-\ ^3P_1$	1 363.459*	
$^3D_1-\ ^3P_0$	1 362.361*	.366 (5)
$3s4p\ ^3P_2-3p4p\ ^3S_1$	1 361.719*	(m)
$3s4s\ ^3S_1-3p4s\ ^3P_2$	1 361.596*	.597 (8)
$3s4p\ ^3P_1-3p4p\ ^3S_1$	1 360.364*	.360 (1)
$^3P_0-\ ^3S_1$	1 359.751*	
$3s3d\ ^3D_1-3p3d\ ^3D_1$	1 343.409*	.388 (6)
$^3D_2-\ ^3D_1$	1 343.365*	
$^3D_1-\ ^3D_2$	1 342.432*	.392 (7)
$^3D_2-\ ^3D_2$	1 342.389*	
$^3D_3-\ ^3D_2$	1 342.351*	
$^3D_2-\ ^3D_3$	1 341.496*	.465 (8)
$^3D_3-\ ^3D_3$	1 341.458*	
$3p^2\ ^1S_0-3p3d\ ^1P_1$	1 328.806*	
$3s4s\ ^1S_0-3s6p\ ^1P_1$	1 327.703	
$3s3p\ ^1P_1-3s4s\ ^1S_0$	1 312.591	.590 (13)
$3s3p\ ^3P_2-3p^2\ ^3P_1$	1 303.323	.320 (16)
$^3P_1-\ ^3P_0$	1 301.149	.146 (14)
$3s4s\ ^1S_0-3p4s\ ^1P_1$	1 300.703*	
$3s3p\ ^3P_2-3p^2\ ^3P_2$	1 298.946	.960 (18)
$^3P_1-\ ^3P_1$	1 298.892	.891 (15)
$^3P_0-\ ^3P_1$	1 296.726	.726 (14)
$^3P_1-\ ^3P_2$	1 294.545	.543 (17)
$3s3d\ ^1D_2-3s6f\ ^1F_3$	1 280.352*	.354 (6)
$3p^2\ ^1S_0-3s6p\ ^1P_1$	1 235.431	.431 (7)

Table 4 (cont.)

Combination	λ_{calc}, Å	λ_{obs}, Å
$3s4p\ ^1P_1-3p4p\ ^1S_0$	1 212.247*	
$3p^2\ ^1S_0-3p4s\ ^1P_1$	1 212.020*	.011 (2)
$3p^2\ ^1D_2-3s4f\ ^1F_3$	1 210.455	.456 (10)
$3p^2\ ^1D_2-3p3d\ ^1D_2$	1 207.517	.517 (9)
$3s3p\ ^1P_1-3s3d\ ^1D_2$	1 206.555	.533 (30)
$3s^2\ ^1S_0-3s3p\ ^1P_1$	1 206.500	.510
$3s3d\ ^3D_1-3p4s\ ^3P_0$	1 198.297*	
$^3D_1-\ ^3P_1$	1 196.470*	
$^3D_2-\ ^3P_1$	1 196.436*	
$^3D_1-\ ^3P_2$	1 192.293*	
$^3D_2-\ ^3P_2$	1 192.258*	
$^3D_3-\ ^3P_2$	1 192.228*	
$3s3d\ ^1D_2-3s7f\ ^1F_3$	1 182.016*	.018 (3)
$3p^2\ ^3P_2-3s5p\ ^3P_2$	1 178.012	.004 (8)
$^3P_2-\ ^3P_1$	1 177.938	
$^3P_1-\ ^3P_2$	1 174.435	.432 (6)
$^3P_1-\ ^3P_1$	1 174.361	.369 (5)
$^3P_1-\ ^3P_0$	1 174.350	
$^3P_0-\ ^3P_1$	1 172.523	.529 (4)
$3p^2\ ^3P_2-3p3d\ ^3P_2$	1 161.579	.579 (8)
$^3P_2-\ ^3P_1$	1 160.252	.255 (6)
$^3P_1-\ ^3P_2$	1 158.101	.102 (7)
$^3P_1-\ ^3P_1$	1 156.782	.782 (4)
$^3P_1-\ ^3P_0$	1 155.959	.957 (6)
$^3P_0-\ ^3P_1$	1 154.998	.998 (6)
$3p^2\ ^3P_2-3p3d\ ^3D_1$	1 145.669	
$3s3d\ ^3D_1-3s5f\ ^3F_2$	1 145.22*	.183 (7)
$^3D_2-\ ^3F_2$	1 145.19*	
$^3D_2-\ ^3F_3$	1 145.177*	
$^3D_3-\ ^3F_2$	1 145.16*	
$^3D_3-\ ^3F_3$	1 145.149*	.114 (8)
$^3D_3-\ ^3F_4$	1 145.122*	
$3p^2\ ^3P_2-3p3d\ ^3D_2$	1 144.959	.959 (6)
$^3P_2-\ ^3D_3$	1 144.309	.306 (8)
$^3P_1-\ ^3D_1$	1 142.285	.282 (6)
$^3P_1-\ ^3D_2$	1 141.579	.580 (7)
$^3P_0-\ ^3D_1$	1 140.546	.545 (6)
$3s3p\ ^3P_2-3s3d\ ^3D_3$	1 113.230	.228 (18)
$^3P_2-\ ^3D_2$	1 113.204	
$^3P_2-\ ^3D_1$	1 113.174	
$^3P_1-\ ^3D_2$	1 109.970	.965 (16)
$^3P_1-\ ^3D_1$	1 109.940	
$^3P_0-\ ^3D_1$	1 108.358	.368 (14)
$3s3d\ ^3D_1-3s6p\ ^3P_0$	1 093.293*	
$^3D_1-\ ^3P_1$	1 093.133*	
$^3D_2-\ ^3P_1$	1 093.105*	
$^3D_1-\ ^3P_2$	1 092.969*	
$^3D_2-\ ^3P_2$	1 092.940*	
$^3D_3-\ ^3P_2$	1 092.915*	
$3p^2\ ^1D_2-3s5p\ ^1P_1$	1 083.216	.210 (6)
$3p^2\ ^3P_2-3p4s\ ^3P_1$	1 037.055	.053 (7)
$^3P_1-\ ^3P_0$	1 035.647	.657 (3)
$^3P_1-\ ^3P_1$	1 034.282	.287 (4)
$^3P_2-\ ^3P_2$	1 033.915	.920 (8)
$^3P_0-\ ^3P_1$	1 032.855	.851 (3)
$^3P_1-\ ^3P_2$	1 031.158	.169 (7)
$3s3d\ ^3D_1-3s6f\ ^3F_2$	1 005.403*	.365 (7)
$^3D_2-\ ^3F_2$	1 005.378*	
$^3D_2-\ ^3F_3$	1 005.374*	
$^3D_3-\ ^3F_2$	1 005.357*	
$^3D_3-\ ^3F_3$	1 005.353*	
$^3D_3-\ ^3F_4$	1 005.349*	
$3s3p\ ^3P_2-3s4s\ ^3S_1$	997.386	.389 (16)
$^3P_1-\ ^3S_1$	994.790	.787 (13)
$^3P_0-\ ^3S_1$	993.519	.519 (10)
$3p^2\ ^1D_2-3s5f\ ^1F_3$	967.944	.946 (9)
$3p^2\ ^1D_2-3p3d\ ^1P_1$	939.097	.093 (7)
$3s3d\ ^3D_1-3s7f\ ^3F_2$	936.100*	.071 (3)
$^3D_2-\ ^3F_2$	936.079*	
$^3D_2-\ ^3F_3$	936.077*	
$^3D_3-\ ^3F_2$	936.060*	
$^3D_3-\ ^3F_3$	936.058*	
$^3D_3-\ ^3F_4$	936.056*	
$3p^2\ ^1D_2-3s6p\ ^1P_1$	891.479	
$3p^2\ ^1D_2-3p3d\ ^1F_3$	883.397	.398 (5)
$3p^2\ ^1D_2-3p4s\ ^1P_1$	879.225	.233 (0)
$3s3p\ ^1P_1-3s4d\ ^1D_2$	823.409	.408 (9)
$3p^2\ ^1D_2-3s6f\ ^1F_3$	822.004	
$3s3p\ ^1P_1-3s5s\ ^1S_0$	800.066	.066 (5)
$3s3p\ ^1P_1-3s5d\ ^1D_2$	690.700	.689 (2)
$3s3p\ ^1P_1-3s6s\ ^1S_0$	678.058	.055 (2)
$3s3p\ ^3P_2-3s4d\ ^3D_1$	673.479	.477 (5)
$^3P_2-\ ^3D_2$	673.477	
$^3P_2-\ ^3D_3$	673.471	
$^3P_1-\ ^3D_1$	672.294	.293 (4)
$^3P_1-\ ^3D_2$	672.292	
$^3P_0-\ ^3D_1$	671.713	.718 (2)
$3s3p\ ^3P_2-3s5s\ ^3S_1$	653.334	.332 (8)
$^3P_1-\ ^3S_1$	652.219	.223 (6)
$^3P_0-\ ^3S_1$	651.672	.668 (4)
$3s3p\ ^1P_1-3s6d\ ^1D_2$	634.255	
$3s3p\ ^1P_1-3p4p\ ^1P_1$	624.997	
$^1P_1-\ ^1D_2$	605.873	
$3s3p\ ^3P_2-3s5d\ ^3D_1$	574.824	
$^3P_2-\ ^3D_2$	574.814	

Table 4 (cont.)

Combination	λ_{calc}, Å	λ_{obs}, Å
$3s3p\ ^3P_2-3s5d\ ^3D_3$	574.799	
$^3P_1-\ ^3D_1$	573.961	
$^3P_1-\ ^3D_2$	573.951	
$^3P_0-\ ^3D_1$	573.538	
$3s3p\ ^1P_1-3p4p\ ^1S_0$	567.878	
$3s^2\ ^1S_0-3s4p\ ^1P_1$	566.613	.613 (8)
$3s3p\ ^3P_2-3s6s\ ^3S_1$	566.546	(m)
$^3P_1-\ ^3S_1$	565.707	.698 (2)
$^3P_0-\ ^3S_1$	565.296	.289 (1)
$3s3p\ ^3P_2-3s6d\ ^3D_1$	534.339	
$^3P_2-\ ^3D_2$	534.276	
$^3P_2-\ ^3D_3$	534.189	
$^3P_1-\ ^3D_1$	533.592	
$^3P_1-\ ^3D_2$	533.530	
$^3P_0-\ ^3D_1$	533.226	
$3s3p\ ^3P_2-3p4p\ ^3D_1$	521.861	
$^3P_2-\ ^3D_2$	521.510	
$3s3p\ ^3P_1-3p4p\ ^3D_1$	521.149	
$^3P_2-\ ^3D_3$	520.910	.92 (0)
$^3P_{1,0}-\ ^3D_{2,1}$	520.799	.79 (00)
$3s3p\ ^3P_2-3p4p\ ^3P_1$	513.245	
$^3P_1-\ ^3P_0$	512.772	
$^3P_2-\ ^3P_2$	512.681	
$^3P_1-\ ^3P_1$	512.557	
$^3P_0-\ ^3P_1$	512.219	
$^3P_1-\ ^3P_2$	511.994	
$3s3p\ ^3P_2-3p4p\ ^3S_1$	511.096	
$^3P_1-\ ^3S_1$	510.414	
$^3P_0-\ ^3S_1$	510.079	
$3s^2\ ^1S_0-3s5p\ ^1P_1$	466.131	.129 (4)
$3s^2\ ^1S_0-3p3d\ ^1P_1$	437.255	
$3s^2\ ^1S_0-3s6p\ ^1P_1$	426.644	
$3s^2\ ^1S_0-3p4s\ ^1P_1$	423.817	

been possible to separate them in the first order. The measurements on weakly exposed spectrograms give a value around λ 1206.510 Å, while λ 1206.533 Å is obtained from strongly exposed spectrograms. L. Minnhagen and B. Peterson (unpublished data, 1960) have found a mean value of λ 1206.503 Å from spectrograms where the line appears weakly as an impurity in a quartz discharge tube. It is to be expected that this value relates mainly to the stronger component—that is, the resonance line, $3s^2\,^1S_0-3s3p\,^1P_1$. This is confirmed by the calculated value of this line, 1206.500 Å.

Three intersystem combination lines, $3s^2\,^1S_0-3s3p\,^3P_1$, $3s3p\,^3P_1-3p^2\,^1D_2$, and $3s3p\,^3P_2-3p^2\,^1D_2$ (see Plate II, *c*) were found in the Schumann region. The first of these was used to determine the level $3s^2\,^1S_0$, the value of which is confirmed by other combinations within their errors of measurements.

Most of the lines in the vacuum region had been found also by Johnson, working in Prof. Shenstone's laboratory, by using a spark between silicon electrodes in helium at a pressure of 3/4 atm. Johnson's wavelength table was kindly communicated to the author by Prof. Shenstone in 1959. Bowen (1932) published measurements of 57 of the strongest lines in the region 1900 Å to 500 Å, the light source being a vacuum spark between metallic silicon electrodes. Some of his wavelengths are included in Table 5.

The term system

Calculation of the terms

The present observational material has been used to recalculate and extend the term system, the result being shown in Table 6 and Fig. 2. The series of the normal triplet system are increased to higher quantum numbers. When it became clear that the line at 1206 Å is complex, the singlet system could also be extended. The longward component of this line gave the term $3s3d\,^1D_2$, which was then confirmed by the aid of several other combinations.

Table 5. Multiplets used to connect the deep terms $3s^2\,{}^1S_0$, $3s3p\,{}^1P_1$, $3p^2\,{}^1D_2$, $3s3p\,{}^3P$, and $3p^2\,{}^3P$ with the upper part of the term system.

N = number of spectrograms, W = weight.

Combination	λ_{obs}, Å		σ_{obs}, cm^{-1}	σ_{calc}	λ_{calc}, Å	N	W
	Present work	Bowen					
$3s3p\ {}^1P_1-3p^2\ {}^1D_2$	2 541.818^a (25)		39 330.11	.11	2 541.818^a	5	80
$3s^2\ {}^1S_0-3s3p\ {}^3P_1$	1 892.030 (3)		52 853.28	S	1 892.030	3	10
$3p^2\ {}^1D_2-3s4p\ {}^1P_1$	1 842.547 (9)	.54	54 272.70	.67	1 842.548	3	10
$3s3p\ {}^3P_2-3p^2\ {}^1D_2$	1 447.196 (6)		69 099.14	.51	1 447.188	3	6
${}^3P_1-\ {}^1D_2$	1 441.732 (5)		69 361.02	.24	1 441.727	2	6
$3s3p\ {}^1P_1-3p^2\ {}^1S_0$	1 417.237 (13)	.20	70 559.83	.82	1 417.237	5	8
$3s3p\ {}^1P_1-3s4s\ {}^1S_0$	1 312.590 (13)	.61	76 185.25	.20	1 312.591	9	7
$3s3p\ {}^3P_2-3p^2\ {}^3P_1$	1 303.320 (16)	.30	76 727.13	6.96	1 303.323	10	7
${}^3P_1-\ {}^3P_0$	1 301.146 (14)	.12	76 855.33	.17	1 301.149	10	7
${}^3P_0-\ {}^3P_1$	1 296.726 (14)	.72	77 117.29	.28	1 296.726	10	7
${}^3P_1-\ {}^3P_2$	1 294.543 (17)	.55	77 247.34	.24	1 294.545	10	7
$3p^2\ {}^1D_2-3s4f\ {}^1F_3$	1 210.456 (10)		82 613.49	.54	1 210.455	10	4
$3p^2\ {}^1D_2-3p3d\ {}^1D_2$	1 207.517 (9)		82 814.57	.57	1 207.517	10	4
$3p^2\ {}^3P_2-3p3d\ {}^3P_2$	1 161.579 (8)	.60	86 089.71	.72	1 161.579	7	4
${}^3P_2-\ {}^3P_1$	1 160.255 (6)	.27	86 187.95	8.17	1 160.252	4	4
${}^3P_1-\ {}^3P_2$	1 158.102 (7)	.11	86 348.18	.27	1 158.101	6	4
${}^3P_1-\ {}^3P_1$	1 156.782 (4)	.80	86 446.71	.72	1 156.782	3	4
${}^3P_1-\ {}^3P_0$	1 155.957 (6)	.96	86 508.41	.29	1 155.959	4	4
${}^3P_0-\ {}^3P_1$	1 154.998 (6)	5.01	86 580.24	.24	1 154.998	4	4
$3p^2\ {}^3P_2-3p3d\ {}^3D_2$	1 144.959 (6)	.99	87 339.37	.40	1 144.959	6	4
${}^3P_2-\ {}^3D_3$	1 144.306 (8)	.31	87 389.21	8.97	1 144.309	9	4
${}^3P_1-\ {}^3D_1$	1 142.282 (6)	.30	87 544.06	3.80	1 142.285	6	4
${}^3P_1-\ {}^3D_2$	1 141.580 (7)	.58	87 597.89	.95	1 141.579	8	4
${}^3P_0-\ {}^3D_1$	1 140.545 (6)	.56	87 677.38	.32	1 140.546	6	4
$3s3p\ {}^3P_2-3s4s\ {}^3S_1$	997.389 (16)	.40	100 261.78	2.04	997.386	11	2
${}^3P_1-\ {}^3S_1$	994.787 (13)	.82	100 524.03	3.77	994.790	11	2
${}^3P_0-\ {}^3S_1$	993.519 (10)	.54	100 652.33	.36	993.519	9	2
$3p^2\ {}^1D_2-3p3d\ {}^1F_3$	883.398 (5)		113 199.3	.41	883.397	3	1
$3s3p\ {}^1P_1-3s4d\ {}^1D_2$	823.408 (9)	.42	121 446.5	.38	823.409	4	1
$3s3p\ {}^1P_1-3s5s\ {}^1S_0$	800.066 (5)	.06	124 989.7	.68	800.066	4	1

[a] λ_{air}.

The term values were calculated by the method of least squares (see Bockasten, 1955) after the wave-numbers for each line had been carefully weighted. The triplet and singlet systems were calculated separately and then connected by means of the intersystem combination lines at 1447 Å and 1441 Å (cf. Fig. 2). It was now possible to find additional intersystem lines, six undisturbed of which occur in the region 6200 Å to 2900 Å, giving a precise connection of the two systems. It follows that $3s5g\,{}^1G_4$ lies between $3s5g\,{}^3G_5$ and ${}^3G_4$, 0.35 cm^{-1} above ${}^3G_4$. For $3s6g$ and $3s7g$ the ${}^1G_4$ level is also situated above the corresponding ${}^3G_4$, while $3s8g\,{}^1G_4$

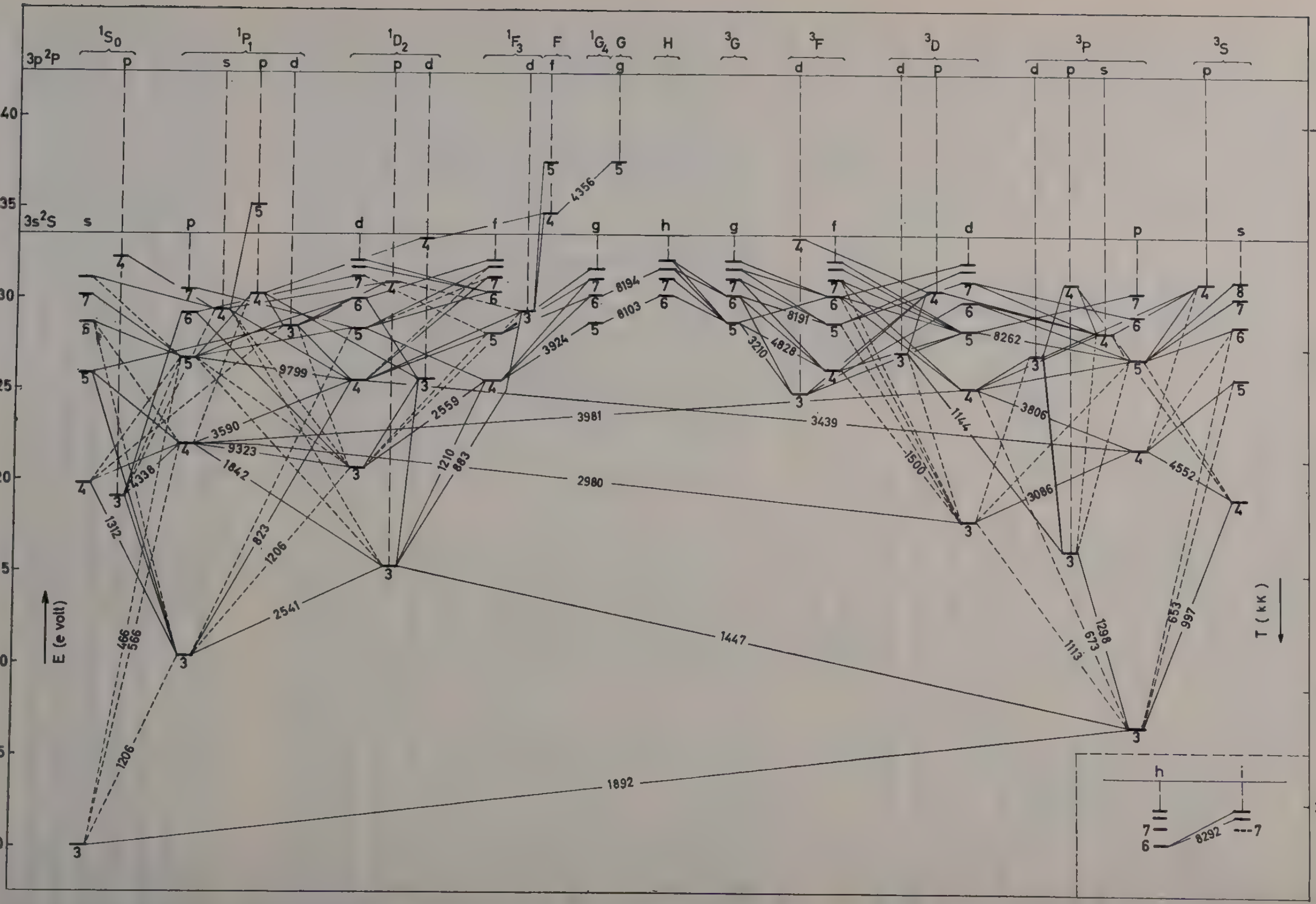

Fig. 2. Term diagram for Si III. Solid lines indicate the observed transitions that were used for the calculation of the term system. Not all observed transitions are drawn. The term values in Figures 2–9 are given in units of 10^3 cm^{-1}

lies 0.2 cm^{-1} below the centre of gravity of $3s8g\,^3G_{4,3}$. As the combinations $3snf\,^1F_3$ $-3sng\,^3G_4$ may also appear and the centres of gravity of the transitions therefore may be shifted somewhat, the uncertainty in the term values in question may reach ± 0.3 cm^{-1}.

Of the g–h transitions $3s5g$–$3s6h$ and $3s6g$–$3s8h$ have been resolved in two components. If one assumes that the three levels of $3snh\,^3H$ and the level $3snh\,^1H$ all coincide within the experimental errors, which is the case already for the G terms in Al II (see Van Vleck & Whitelaw, 1933), the difference between the two components of the doublet $5g$–$6h$ indicates that one of them should be the transitions $3s5g\,^3G_{4,3}$–$3s6h\,^3H_{5,4}$ and the other a blend of $3s5g\,^3G_5$–$3s6h\,^3H_6$ and $3s5g\,^1G_4$–$3s6h\,^1H_5$, $^3H_5$. The long-wave component of the doublet $6g$–$8h$ is blended by Na I, but it has been measured on spectrograms where the Na I contribution can be neglected. If this line is interpreted as $3s6g\,^3G_5$–$3s8h\,^3H_6$, and if one assumes again that all the four levels of $3s8h$ coincide, the other component of the doublet then gives a value for the centre of gravity of $3s6g\,^3G_{4,3}$, $^1G_4$, which agrees well with the predicted one (cf. Table 2).

The narrow splittings of the $3sng\,^3G$ terms were indirectly determined from the differences between the observed intervals of their combinations with ^3F terms and the true ^3F intervals. The splittings in 6, 7, and $8f\,^3F$ were derived from combinations with $5d\,^3D$. The fine-structure splittings of $3s8d\,^3D$ were predicted by use of the relation $\Delta n^* = C(T_n - T_0)^{-2}$ (cf. Edlén, 1960), where C is a constant, T_n the term values of the $3snd$ terms, and T_0 the perturbing term $3p4p\,^3D$. C was determined from $3s6d$ and $3s7d\,^3D$.

The transitions used in connecting the deep terms with the upper part of the term system are again collected in Table 5. The experimentally found wave-numbers (column 4) were carefully weighted (see column 8), and the term values calculated by the method of least squares. In the fifth column the recalculated wave-numbers are tabulated for a comparison with the observed ones.

The configurations 3p4f and 3p5g

There is only one observed transition between $3p3d\,^1F_3$ and the configuration $3p4f$. This may be explained by assuming that the terms $3p4f\,^1D_2$ and $^1G_4$ are autoionized by interaction with the $3snd\,^1D_2$ and $3sng\,^1G_4$ continua so that only $3p4f\,^1F_3$ remains observable. A multiplet of six lines was found, however, which may be ascribed to the transition $3p4f$–$3p5g$. The intensities of these lines show that it cannot be a transition between two regular LS triplet terms. One may assume that the configuration $3p5g$ has pair coupling, while the coupling of $3p4f$ is partly of LS character. There are some very hazy, weak lines that may be Si III lines in the region where transitions between the other levels of the configurations $3p4f$ and $3p5g$ should appear. Their shape indicates that they may involve partly auto-ionized levels. The strong perturbation of the $3sng$ terms (see Fig. 4) indicates that $3p4f\,^{3,1}G$ has some LS character. Only the above-mentioned strong multiplet of $3p4f$–$3p5g$ has been included in Table 2.

The term table

The final term values of Si III are given in Table 6. It contains 147 levels, only 40 of which were known before. The terms $3s5p\,^3P$ and $3s5p\,^1P_1$ had been found independently by Johnson (Shenstone, 1958) from transitions in the vacuum-ultraviolet region. The displaced system, based on the limit $3p\,^2P$, includes complete sets of terms of the configurations $3p^2$, $3p3d$, $3p4s$, and $3p4p$. The terms $3p5p\,^1P_1$, $3p4d\,^1D_2$,

Table 6. The term system of Si III.

p = predicted values.

Term symbol	E, cm^{-1}		Term symbol	E, cm^{-1}	
$3s^2\ ^1S_0$	0.00		$3p^2\ ^3P_2$	130 100.52	258.55
$3s3p\ ^3P_2$	53 115.01	261.73	$^3P_1$	129 841.97	133.52
$^3P_1$	52 853.28	128.59	$^3P_0$	129 708.45	
$^3P_0$	52 724.69		$^1D_2$	122 214.52	
$^1P_1$	82 884.41		$^1S_0$	153 444.23	

Limit: $3s\ ^2S_{\frac{1}{2}}$, $E = 270\,139.29$ cm^{-1}

Term symbol	E, cm^{-1}	ΔE, cm^{-1}	T, cm^{-1}	n^*
$3s4s\ ^3S_1$	153 377.05		116 762.24	2.908 325 2
$^1S_0$	159 069.61		111 069.68	2.981 922 9
$3s5s\ ^3S_1$	206 176.08		63 963.21	3.929 425
$^1S_0$	207 874.09		62 265.20	3.982 644
$3s6s\ ^3S_1$	229 623.19		40 516.10	4.937 196
$^1S_0$	230 364.46		39 774.83	4.982 990
$3s7s\ ^3S_1$	242 145.10		27 994.19	5.939 641
$^1S_0$	242 537.95		27 601.34	5.981 761
$3s8s\ ^3S_1$	249 766.19		20 373.10	6.962 507
$^1S_0$	249 857,26		20 282.03	6.978 121
$3s4p\ ^3P_2$	175 336.26	73.16	94 803.03	3.227 625
$^3P_1$	175 263.10	33.09	94 876.19	3.226 380
$^3P_0$	175 230.01		94 909.28	3.225 818
$^1P_1$	176 487.19		93 652.10	3.247 397
$3s5p\ ^3P_2$	214 989.27	−5.38	55 150.02	4.231 763
$^3P_1$	214 994.65	−0.81	55 144.64	4.231 969
$^3P_0$	214 995.46		55 143.83	4.232 001
$^1P_1$	214 532.17		55 607.12	4.214 334
$3s6p\ ^3P_2$	234 442.18	13.78	35 697.11	5.259 902
$^3P_1$	234 428.40	13.33	35 710.89	5.258 887
$^3P_0$	234 415.07		35 724.22	5.257 906
$^1P_1$	234 387.64		35 751.65	5.255 888
$3s7p\ ^3P_2$	244 943.31	9.95	25 195.98	6.260 782
$^3P_1$	244 933.36	4.64	25 205.93	6.259 546
$^3P_0$	244 928.72		25 210.57	6.258 970
$^1P_1$	244 871.47		25 267.82	6.251 875
$3s3d\ ^3D_3$	142 943.74	−2.10	127 195.55	2.786 494 7
$^3D_2$	142 945.84	−2.41	127 193.45	2.786 517 7
$^3D_1$	142 948.25		127 191.04	2.786 544 1
$^1D_2$	165 765.00		104 374.29	3.076 078 5
$3s4d\ ^3D_3$	201 599.48	1.20	68 539.81	3.795 970
$^3D_2$	201 598.28	0.55	68 541.01	3.795 936
$^3D_1$	201 597.73		68 541.56	3.795 921
$^1D_2$	204 330.79		65 808.50	3.873 943

Table 6 (cont.)

Term symbol	E, cm^{-1}	ΔE, cm^{-1}	T, cm^{-1}	n^*
$3s5d\ ^3D_3$	227 088.72	4.51	43 050.57	4.789 660
$^3D_2$	227 084.21	3.02	43 055.08	4.789 410
$^3D_1$	227 081.19		43 058.10	4.789 242
$^1D_2$	227 665.09		42 474.20	4.822 048
$3s6d\ ^3D_3$	240 314.63	30.35	29 824.66	5.754 485
$^3D_2$	240 284.28	22.00	29 855.01	5.751 559
$^3D_1$	240 262.28		29 877.01	5.749 441
$^1D_2$	240 549.77		29 589.52	5.777 304
$3s7d\ ^3D_3$	249 121.14	17.24	21 018.15	6.854 834
$^3D_2$	249 103.90	10.4	21 035.39	6.852 024
$^3D_1$	249 093.5		21 045.8	6.850 33
$^1D_2$	250 636.55		19 502.74	7.116 171
$3s8d\ ^3D_3$	254 007.48	3	16 131.81	7.824 429
$^3D_2$	254 004. *p*	2	16 135.	7.823 7
$^3D_1$	254 002. *p*		16 137.	7.823 2
$^1D_2$	254 766.75		15 372.54	8.015 329
$3s9d\ ^3D_{3,2,1}$	257 415.6		12 723.7	8.810 23
$^1D_2$	257 848.5		12 290.8	8.964 05
$3s4f\ ^3F_4$	209 599.70	40.37	60 539.59	4.039 005
$^3F_3$	209 559.33	27.93	60 579.96	4.037 659
$^3F_2$	209 531.40		60 607.89	4.036 729
$^1F_3$	204 828.06		65 311.23	3.888 662
$3s5f\ ^3F_4$	230 270.66	2.04	39 868.63	4.977 125
$^3F_3$	230 268.62	0.9	39 870.67	4.976 997
$^3F_2$	230 267.7		39 871.6	4.976 94
$^1F_3$	225 526.33		44 612.96	4.705 044
$3s6f\ ^3F_4$	242 411.70	0.43	27 727.59	5.968 128
$^3F_3$	242 411.27	0.39	27 728.02	5.968 082
$^3F_2$	242 410.88		27 728.41	5.968 040
$^1F_3$	243 868.50		26 270.79	6.131 371
$3s7f\ ^3F_4$	249 774.98	0.28	20 364.31	6.964 009
$^3F_3$	249 774.70	0.22	20 364.59	6.963 961
$^3F_2$	249 774.48		20 364.81	6.963 924
$^1F_3$	250 366.22		19.773.07	7.067 359
$3s8f\ ^3F_4$	254 557.64	0.38	15 581.65	7.961 363
$^3F_3$	254 557.26	0.23	15 582.03	7.961 266
$^3F_2$	254 557.03		15 582.26	7.961 208
$^1F_3$	254 855.42		15 283.87	8.038 546
$3s9f\ ^3F_{4,3,2}$	257 831.4		12 307.9	8.957 82
$^1F_3$	258 013.37		12 125.92	9.024 784
$3s5g\ ^3G_5$	230 302.35	0.69	39 836.94	4.979 104
$^3G_4$	230 301.66	0.44	39 837.63	4.979 061
$^3G_3$	230 301.22		39 838.07	4.979 033
$^1G_4$	230 302.01		39 837.28	4.979 083
$3s6g\ ^3G_5$	242 474.81	0.95	27 664.48	5.974 931
$^3G_4$	242 473.86	0.20	27 665.43	5.974 829
$^3G_3$	242 473.66		27 665.63	5.974 807

Table 6 (cont.)

Term symbol	E, cm^{-1}	ΔE, cm^{-1}	T, cm^{-1}	n^*
$3s6g\ {}^1G_4$	242 474.27		27 665.02	5.974 873
$3s7g\ {}^3G_5$	249 818.93	1.08	20 320.36	6.971 536
${}^3G_4$	249 817.85	0.53	20 321.44	6.971 351
${}^3G_3$	249 817.32		20 321.97	6.971 260
${}^1G_4$	249 817.94		20 321.35	6.971 366
$3s8g\ {}^3G_5$	254 585.75	1.0	15 553.54	7.968 555
${}^3G_{4,3}$	254 584.8		15 554.5	7.968 31
${}^1G_4$	254 584.6		15 554.7	7.968 26
$3s9g\ {}^3G_{5,4,3}$	257 853.6		12 285.7	8.965 91
$3s6h\ H$	242 639.38		27 499.91	5.992 783
$3s7h\ H$	249 937.29		20 202.00	6.991 929
$3s8h\ H$	254 674.4		15 464.9	7.991 37
$3s9h\ H$	257 922.0		12 217.3	8.990 97
$3s7i\ I$	249 966.49 p		20 172.80	
$3s8i\ I$	254 694.99		15 444.30	7.996 686
$3s9i\ I$	257 936.99		12 202.30	8.996 495
$3s8k\ K$	254 702.29 p		15 437.00	
$3s9k\ K$	257 942.30 p		12 196.99	
$3s9l\ L$	257 944.45 p		12 194.84	
Limits: $3p\ {}^2P1\frac{1}{2}$, $E = 341\ 887.93$ cm^{-1}; ${}^2P_{\frac{1}{2}}$, $E = 341\ 426.83$ cm^{-1}.				
$3p4s\ {}^3P_2$	226 820.28	292.86	115 067.65	2.929 662 3 $(1\frac{1}{2})$
${}^3P_1$	226 527.42	127.42	114 899.41	2.931 806 3 $(\frac{1}{2})$
${}^3P_0$	226 400.00		115 026.83	2.930 182 0 $(\frac{1}{2})$
${}^1P_1$	235 951.09		105 936.84	3.053 308 4 $(1\frac{1}{2})$
$3p4p\ {}^3D_3$	245 086.58	220.53	96 801.35	3.194 136 $(1\frac{1}{2})$
${}^3D_2$	244 866.05	129.12	96 560.78	3.198 113 $(\frac{1}{2})$
${}^3D_1$	244 736.93		96 689.90	3.195 977 $(\frac{1}{2})$
${}^3P_2$	248 168.04	214.35	93 719.89	3.246 223 $(1\frac{1}{2})$
${}^3P_1$	247 953.69	82.03	93 934.24	3.242 517 $(1\frac{1}{2})$
${}^3P_0$	247 871.66		93 555.17	3.249 079 $(\frac{1}{2})$
${}^3S_1$	248 772.86		93 115.07	3.256 748 $(1\frac{1}{2})$
${}^1D_2$	247 935.39		93 952.54	3.242 201 $(1\frac{1}{2})$
${}^1P_1$	242 885.30		98 541.53	3.165 808 $(\frac{1}{2})$
${}^1S_0$	258 978.66		82 909.27	3.451 379 $(1\frac{1}{2})$
$3p5p\ {}^1P_1$(?)	282 291.19 (?)		59 135.64	4.086 670 $(\frac{1}{2})$
$3p3d\ {}^3F_4$	199 164.10	137.61	142 723.83	2.630 546 2 $(1\frac{1}{2})$
${}^3F_3$	199 026.49	103.34	142 400.34	2.633 532 4 $(\frac{1}{2})$
${}^3F_2$	198 923.15		142 503.68	2.632 577 4 $(\frac{1}{2})$
${}^3D_3$	217 489.49	49.57	124 398.44	2.817 647 8 $(1\frac{1}{2})$
${}^3D_2$	217 439.92	54.15	124 448.01	2.817 086 6 $(1\frac{1}{2})$
${}^3D_1$	217 385.77		124 502.16	2.816 473 9 $(1\frac{1}{2})$
${}^3P_2$	216 190.24	−98.45	125 697.69	2.803 047 9 $(1\frac{1}{2})$
${}^3P_1$	216 288.69	−61.57	125 138.14	2.809 307 8 $(\frac{1}{2})$
${}^3P_0$	216 350.26		125 537.67	2.804 834 0 $(1\frac{1}{2})$

Table 6 (cont.)

Term symbol	E, cm^{-1}	ΔE, cm^{-1}	T, cm^{-1}	n^*
$3p3d\,^1F_3$	235 413.93		106 474.00	3.045 596 7 $(1\frac{1}{2})$
$^1D_2$	205 029.09		136 397.74	2.690 856 8 $(\frac{1}{2})$
$^1P_1$	228 699.75		113 188.18	2.953 885 4 $(1\frac{1}{2})$
$3p4d\,^3F_4$ (?)	267 686.48		74 201.45	3.648 278 $(1\frac{1}{2})$
$^1D_2$ (?)	267 483.87		73 942.96	3.654 650 $(\frac{1}{2})$
$3p4f$ $F(3\frac{1}{2})_4$ (?)	278 938.08 + x			$(\frac{1}{2})$
$F(3\frac{1}{2})_3$ (?)	278 938.08		62 488.75	3.975 514 $(\frac{1}{2})$
$F(2\frac{1}{2})_3$ (?)	278 920.68		62 506.15	3.974 960 $(\frac{1}{2})$
$3p5f$ $F(3\frac{1}{2})_3$ (?)	301 484.51		39 942.32	4.972 531 $(\frac{1}{2})$
$3p5g$ $G(4\frac{1}{2})_5$	301 884.14 + x	−6.83		$(\frac{1}{2})$
$G(4\frac{1}{2})_4$	301 890.97 + x			$(\frac{1}{2})$
$G(3\frac{1}{2})_4$	301 892.26	4.32	39 534.57	4.998 108 $(\frac{1}{2})$
$G(3\frac{1}{2})_3$	301 887.94		39 538.89	4.997 835 $(\frac{1}{2})$

$3p4d\,^3F_4$, and some $3pnf$ and $3p5g$ terms have also been found (cf. above). Three levels belonging to the two last-mentioned configurations could not be connected with the rest of the term system, because many strong O II and Si III lines appear at the position predicted for the $3p4f(3\frac{1}{2})_3$–$3p5g(4\frac{1}{2})_4$ transition, which is probably masked by one of these lines. These three levels are marked $+x$ in Table 6.

The levels $3snd\,^1D_2$ for $n = 7$, 8, and 9 are based on only one transition each. The identification of $7d\,^1D_2$ is, however, supported by the line λ 3981 Å, and the levels $8d$ and $9d$ are confirmed by the series diagram (Fig. 6).

The agreement between observed and recalculated wave-numbers shown in Table 2 indicates an average accuracy of about ± 0.1 cm^{-1} in the tabulated level values for most of the terms that are based on measurements above 2000 Å. From Table 5 one may estimate the errors in the deep terms to be not more than 0.2 cm^{-1}. A comparison with the term values given in *Atomic Energy Levels*, Vol. I, which are based on the analysis by Bowen, shows a good agreement for the singlet system. The differences range from +1.2 to +1.6 cm^{-1}, the main part of which originates from the error in the adopted value for the resonance line, the double structure of λ 1206 not being noticed. The differences in the triplet term values vary from +93.3 to +96.6 cm^{-1}, the mean shift being +96.1 cm^{-1}.

Calculated wavelengths in the vacuum region

Wavelengths calculated by use of the combination principle are collected in Table 4. Those values that were derived only from observations above 2000 Å are starred. The errors in these wavelengths are estimated to range from 0.005 Å at 2000 Å to 0.002 Å at 1300 Å. The other values should have a maximum error of 0.005 Å at 1500 Å and 0.0005 Å at 500 Å.

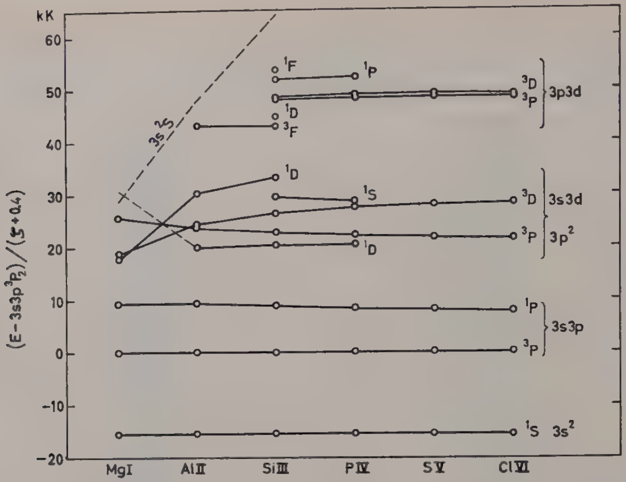

Fig. 3. Relative term values in the isoelectronic sequence from Mg I through Cl VI.

Comparison with isoelectronic spectra

Fig. 3 shows a comparison of terms having $n=3$ for both valence electrons through the isoelectronic sequence from Mg I to Cl VI. In order to make all the curves approximately parallel the relative term values, E–$3s3p\,^3P_2$, have been divided by $(\zeta+0.4)$, ζ being the net charge of the atomic core (Edlén, 1960). From the run of the curves one finds that some terms of Al II and P IV, not included in the diagram, may have to be revised. For instance, the term labelled $3p^2\,^1D_2$ in P IV (Robinson, 1937) is probably not real. In the beginning of the isoelectronic sequence there are several irregularities due to configuration interactions, but after the first few members the trend is stabilized. The diagram in Fig. 3 may help to find missing terms in other members of the isoelectronic sequence.

Ionization limit

The only unperturbed Rydberg series of Si III are the $3snh$ and $3sni$ series. The configurations $3pnl$ with $l \geqslant 4$ are estimated to be close to pair coupling, and since they are situated far above the first ionization limit, perturbations from these terms on the $3snh$ and $3sni$ series can probably be neglected. In the $3sni$ series only the members with $n=8$ and 9 have been observed. One can therefore calculate the ionization limit by using a Ritz formula based on the $3snh$ series, or by using the polarization formula (see Toresson, 1960) based on terms in the $3snh$ and $3sni$ series. The term values for $3s6h$, $3s7h$, and $3s8i$ fitted to the polarization formula give the value $E_0=270139.2$ cm^{-1} for the ionization limit. From a Ritz formula based on the terms $3s6h$, $7h$, and $8h$ the value 270139.3 cm^{-1} is obtained. If the term values are

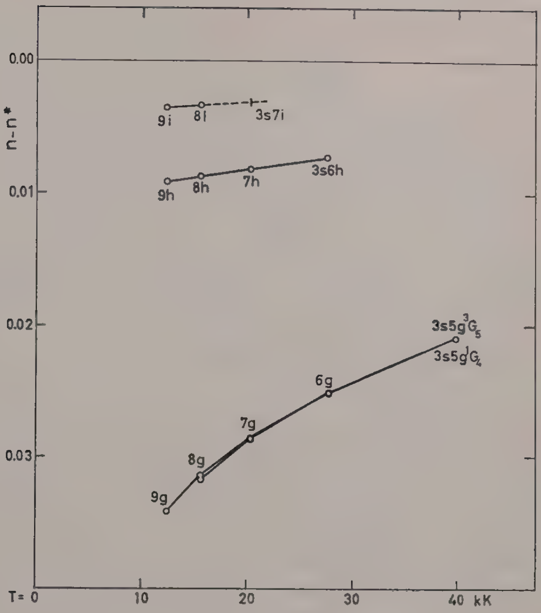

Fig. 4. Quantum defects, n–n^*, for the series 3*sng*, 3*snh*, and 3*sni*.

corrected for an estimated influence of the Stark effect (see Bockasten, 1956), the value of the ionization limit would become about 0.5 cm^{-1} higher. However, as this estimation of the Stark effect is very uncertain, the value

$$E_0 = 270\,139.3 \pm 0.4 \text{ cm}^{-1}$$

has been accepted. The uncertainty in the term value of $3s7h$, depending on the difficulty in fixing the centre of gravity of the $3s5g$ term correctly, may cause an error in the ionization limit of about 0.2 cm^{-1}. The absolute term values, $T = E_0 - E$, are given in column 4 of Table 6 and the effective quantum numbers n^* in the fifth column. The limit $^2P_{1\frac{1}{2}}$ or $^2P_{\frac{1}{2}}$ for each level series of the displaced system is determined by assuming that the curves for levels with the same J- value in a centroid diagram do not cross.

Perturbations

The two terms $3s3d\,^1D_2$ and $3p^2\,^1D_2$ strongly perturb each other. Their eigenfunctions are therefore mixed and their characters almost identical. The configuration assignments adopted here have been chosen after a study of their n^* values and positions in the isoelectronic diagram (see Fig. 3). The term $3p^2\,^1D_2$ given in *Atomic Energy Levels* is not real.

The quantum defects $\delta = n - n^*$, are plotted against T in Figs. 4, 5, 6, and 9. Series perturbations cause some striking irregularities in the curves. The positions of the perturbing terms are shown in the diagrams. The term $3p^2\,^1S_0$ seems to perturb $3s4s\,^1S_0$ very little, while the perturbations increase strongly with L. The perturbations

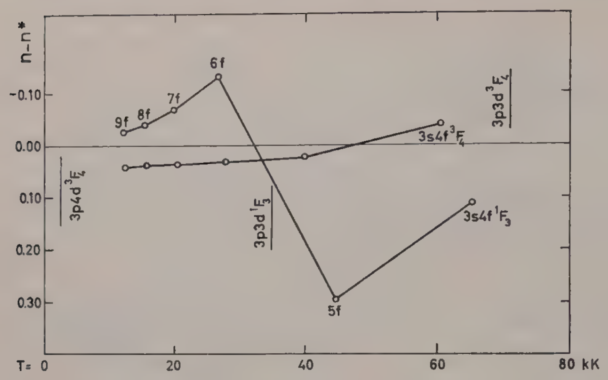

Fig. 5. Perturbation of the series $3snf\,{}^3F_4$ and ${}^1F_3$ by the levels $3p3d\,{}^3F_4$ and ${}^1F_3$.

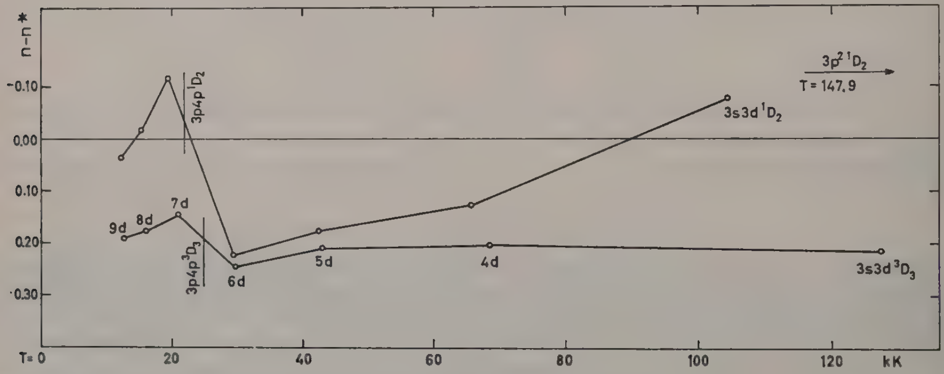

Fig. 6. Perturbations in the series $3snd$. The perturbing term $3p^2\,{}^1D_2$ is situated at $T = 147.9$ *kK*.

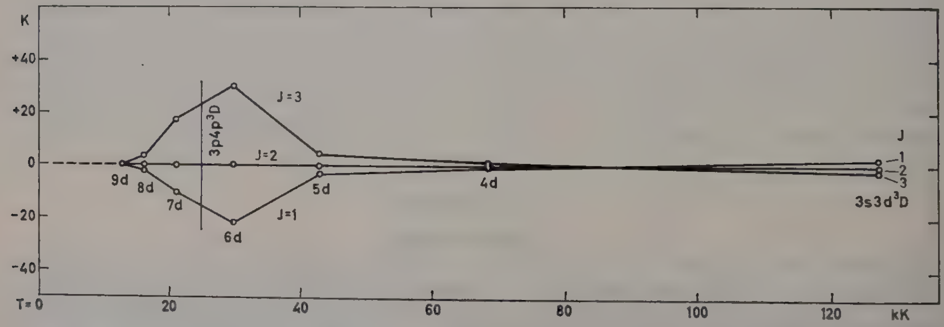

Fig. 7. Fine-structure splittings in the ${}^3D$ series. The intervals in $3s8d\,{}^3D$ are predicted.

are on the whole stronger for the singlets than for the triplets. This may be the reason why the ${}^1G_4$ terms depart from $3sng\,{}^3G_5$ as n increases (cf. Fig. 4).

The most perturbed terms of the normal triplet system belong to the configurations $3s4f$, $3s6d$, and $3s7d$, and in each of these cases the fine-structure splitting is

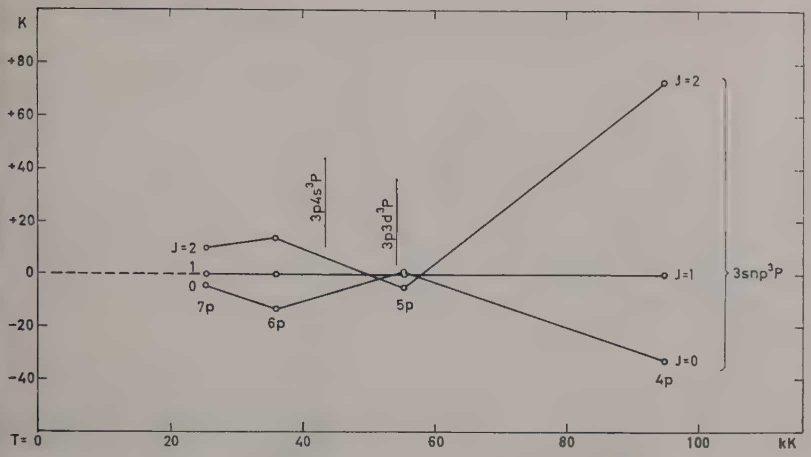

Fig. 8. Fine-structure splittings in some ^3P terms.

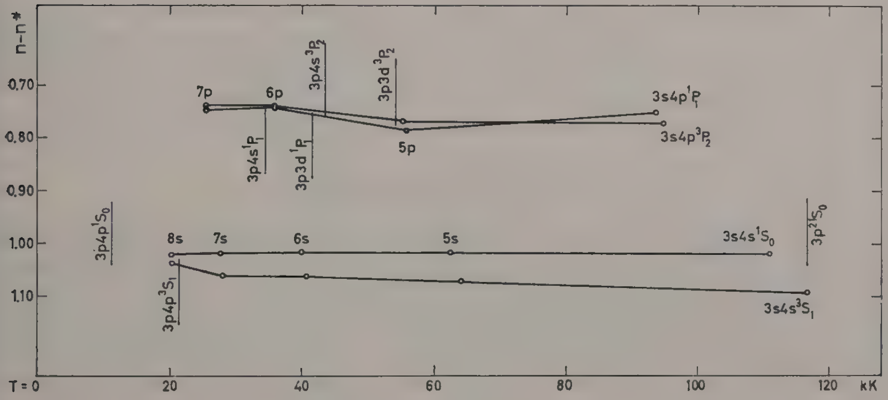

Fig. 9. The series $3snp$ and $3sns$ with the perturbing terms indicated.

much greater than expected. The term $3s5p\,^3P$ is inverted owing to the interaction with $3p3d\,^3P$, which has a large negative splitting factor. Figs. 7 and 8 show the splittings of the ^3D and ^3P series.

Calculations of hydrogen-like term values

Term values for the H, I, K, and L series have been calculated up to $n=9$ by use of the polarization formula

$$\Delta_p = AP(n,l)[1+kr(n,l)],$$

where Δ_p is the polarization energy, A and k are constants, and $P(n,l)$ and $r(n,l)$

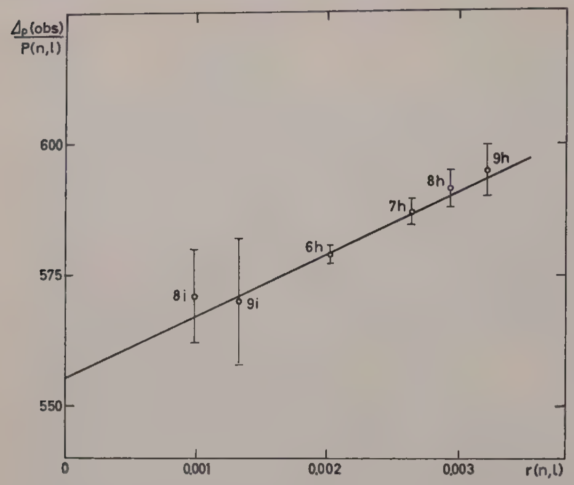

Fig. 10. Diagram showing Δ_p(obs)/ $P(n,l)$ as a function of $r(n,l)$ for hydrogen-like terms of Si III.

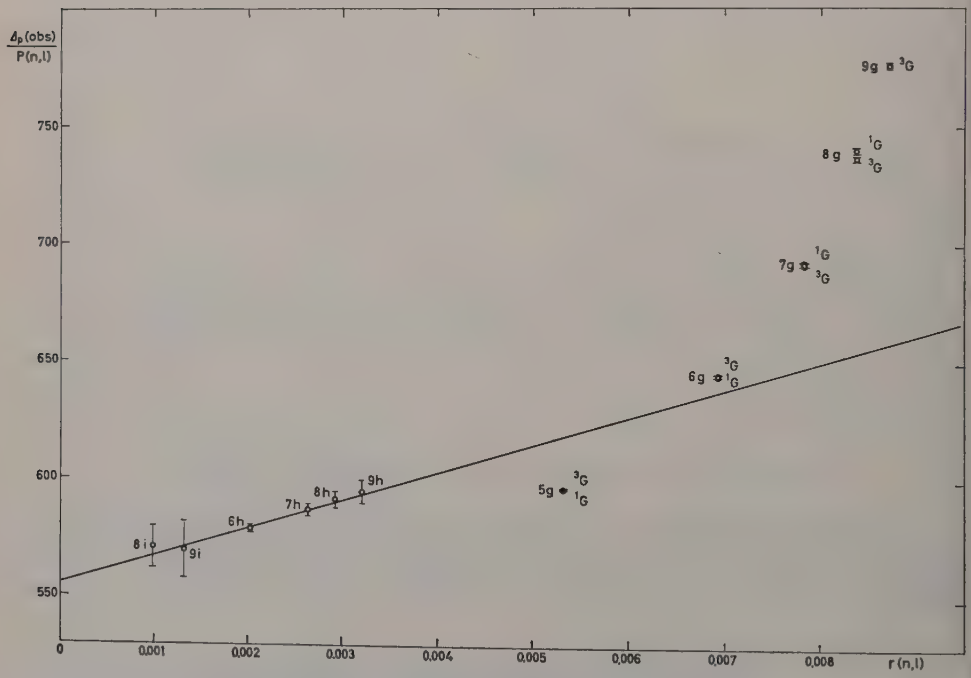

Fig. 11. The same diagram as in Fig. 10 with $3sng\,^3G_c$ and $^1G_4$ included.

rational functions of the orbital quantum numbers n and l of the valence electron (see Toresson, 1960). Since $\Delta_p = T - T_H$, and T_H is the hydrogenic term value, the value of Δ_p depends on the relativistic correction Δ_r, which, however, is very small compared to Δ_p (see Table 7) and therefore might have been neglected. However, the values of Δ_r, which are valid for a one-electron spectrum, have been accepted as

Table 7. Comparison between calculated and observed values (in cm^{-1}) of hydrogen-like terms of Si III.

$\Delta_p\,(\text{calc}) = 555.5\,P\,(n,l)\,[1 + 21.2\,r\,(n,l)]$

Term	Δ_r	T_H	Δ_p (calc)	Δ_p (obs)	Δ_p (obs)– Δ_p (calc)	T (calc)
$3s6h\ H$	0.12	27 433.91	66.04	66.00	−0.04	27 499.95
$3s7h\ H$	0.10	20 155.54	46.42	46.46	0.04	20 201.96
$3s8h\ H$	0.08	15 431.59	33.16	33.3	0.1	15 464.75
$3s9h\ H$	0.06	12 192.86	24.33	24.4	0.1	12 217.19
$3s7i\ I$	0.06	20 155.50	17.30			20 172.80
$3s8i\ I$	0.06	15 431.57	12.65	12.73	0.08	15 444.22
$3s9i\ I$	0.05	12 192.85	9.47	9.45	−0.02	12 202.32
$3s8k\ K$	0.04	15 431.55	5.45			15 437.00
$3s9k\ K$	0.03	12 192.83	4.16			12 196.99
$3s9l\ L$	0.02	12 192.82	2.02			12 194.84

approximate corrections in this work. The parameters $A = 555.5$ and $k = 21.2$ were derived graphically from Fig. 10 by using the terms $3snh$ and $3sni$ according to the method suggested by Edlén (1960). In Figs. 10 and 11 the shifts caused by an error $\Delta T = \pm 0.2\ \text{cm}^{-1}$ are indicated. Calculated and observed values of Δ_p are compared in Table 7, where the calculated term values are shown in the last column.

Description of Plates I–III

All of the spectrograms were taken with the sliding vacuum spark. The spectrograph was used in the first order for the spectrograms of Plate I (4.77 Å/mm), and in the second order for *a* and *b* of Plate II (2.44 Å/mm). Plate III and the spectrogram *c* of Plate II are from the vacuum spectrograph. The plate factor was 5.36 Å/mm at 1850 Å, 4.85 Å/mm at 1450 Å, and 4.46 Å/mm at 1200 Å. The data of the plates are given in Table 8.

Table 8. Data of the plates.

Plate	Spectro-gram	Condenser μF	External gap, mm	Induction coil no. of turns*	Exposure time, min.	Type of photographic plate
I	*a*	0.30	4	20	10	Eastman Kodak I–N hypersensitized
	b	0.30	4	20	30	
	c	0.30	4	20	80	
II	*a*	0.30	2	29	10	Eastman Kodak 103a–O
	b	0.30	6	15	10	
	c	0.30	2	29	120	Ilford Q_2
III	*a*	0.30	2	29	15	Ilford Q_1
	b	0.30	4	20	60	Ilford Q_2
	c	0.30	2	29	15	Ilford Q_1
	d	0.30	4	20	60	Ilford Q_2

* Each turn gives an inductance of 2 μH.

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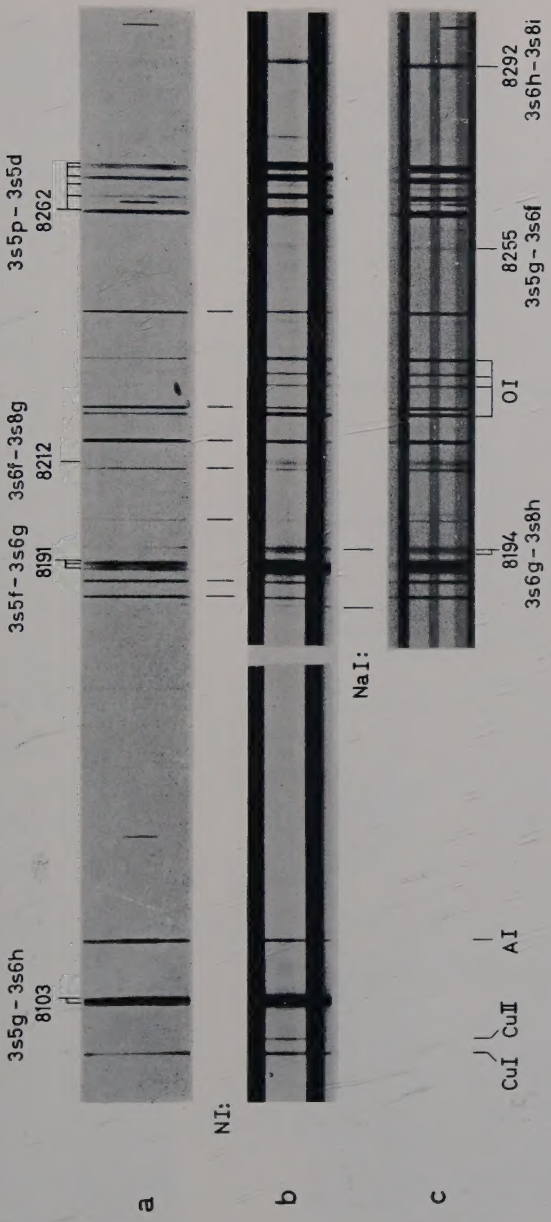
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NaI:
CuI
CuII
AI
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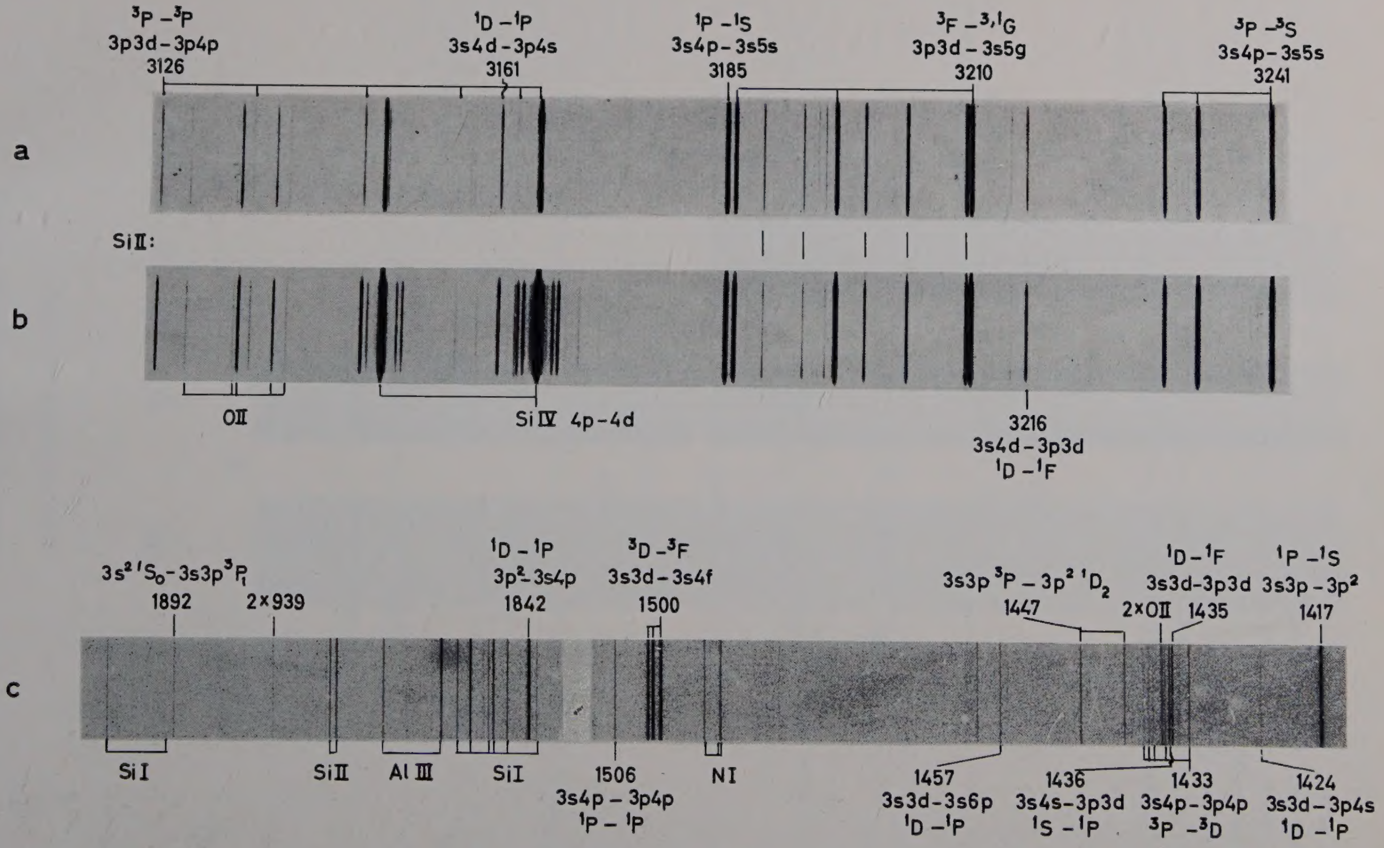
OI
8255
3s5g-3s6f
8292
3s6h-3s8i
a
b
c


a
b
c
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$^1D-^1P$ 3s4d-3p4s 3161
$^1P-^1S$ 3s4p-3s5s 3185
$^3F-^{3,1}G$ 3p3d-3s5g 3210
$^3P-^3S$ 3s4p-3s5s 3241
Si II:
O II
Si IV 4p-4d
3216 3s4d-3p3d $^1D-^1F$
$3s^2\,^1S_0-3s3p\,^3P_1$ 1892
2×939
$^1D-^1P$ $3p^2-3s4p$ 1842
$^3D-^3F$ 3s3d-3s4f 1500
$3s3p\,^3P-3p^2\,^1D_2$ 1447
2×O II
$^1D-^1F$ 3s3d-3p3d 1435
$^1P-^1S$ $3s3p-3p^2$ 1417
Si I
Si II
Al III
Si I
1506 3s4p-3p4p $^1P-^1P$
N I
1457 3s3d-3s6p $^1D-^1P$
1436 3s4s-3p3d $^1S-^1P$
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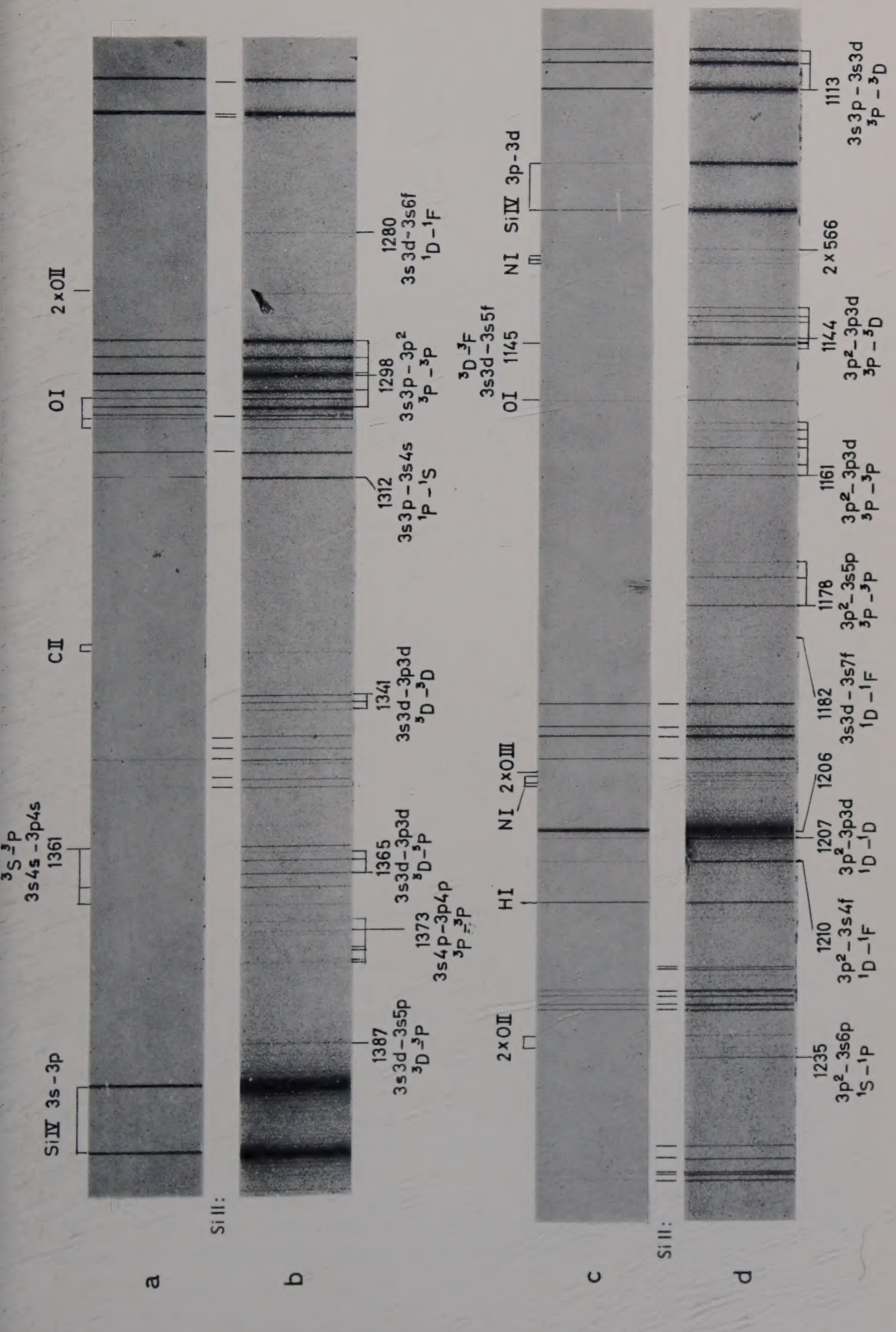
a
b
c
d
Si II:
Si IV 3s-3p
1361 3s4s-3p4s $^3S-^3P$
C II
O I
2×O II
1280 3s3d-3s6f $^1D-^1F$
1298 3s3p-3p^2 $^3P-^3P$
1312 3s3p-3s4s $^1P-^1S$
1341 3s3d-3p3d $^3D-^3D$
1365 3s3d-3p3d $^3D-^3P$
1373 3s4p-3p4p $^3P-^3P$
1387 3s3d-3s5p $^3D-^3P$
Si IV 3p-3d
N I
O I 1145 3s3d-3s5f $^3D-^3F$
2×O III
N I
H I
2×O II
Si II:
1113 3s3p-3s3d $^3P-^3D$
2×566
1144 3p^2-3p3d $^3P-^3D$
1161 3p^2-3p3d $^3P-^3P$
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